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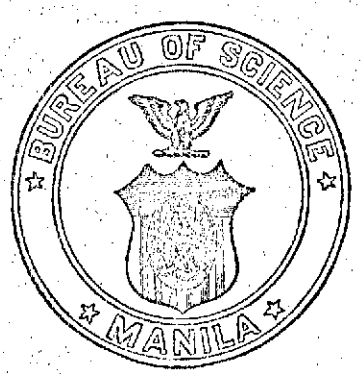

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THE PHILIPPINE
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VOL. 19 DECEMBER, 1921 No. 6

VARIOUS METHODS OF SERUM APPLICATION IN BACILLARY DYSENTERY [1]

By PEDRO T. LANTIN

Of the Department of Medicine, College of Medicine and Surgery, University of the Philippines, and Resident Physician of the Philippine General Hospital, Manila

SIX TEXT FIGURES

In my preliminary paper, published in 1918,(5) I reported upon the employment of serum by various methods in a limited number of cases of bacillary dysentery. Fortunately, I have been able to continue my observations on a larger number of cases.

During the twelve months of 1918, there were admitted to the medical wards one hundred sixty-four cases of bacillary dysentery. With the exception of two cases all were Filipino patients. One of the two was a Japanese, and the other was an American who had been in the Philippine Islands a long time. Both sexes were represented in these studies; the sex incidence was as follows:

TABLE 1.—*Sex incidence.*

Sex.	Cases.
Male	114
Female	50
Total	164

AGE INCIDENCE

It is common experience that no age is exempt from the disease. It appears from my series that young adults are most subject to attack. The age incidence is shown in Table 2.

[1] Read before the Manila Medical Society, March 3, 1919.

TABLE 2.—*Age incidence.*

Years.	Cases.
14 to 20	40
20 to 30	80
30 to 40	19
40 to 50	9
50 to 60	8
60 to 70	8
70 to 80	0
Total	164

Table 2 shows that the greatest number of cases occurred in young adults from 20 to 30 years of age. This observation is similar to Shiga's(9) findings, in Japan, who also observed a great number of cases between the ages of 20 and 30 years. A graphic representation of age incidence is shown in fig. 1.

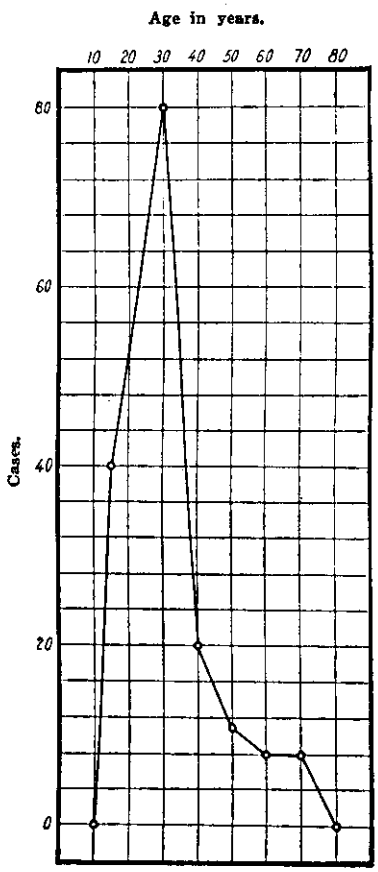

FIG. 1. Illustrating the age incidence by decades.

SEASONAL INCIDENCE

The disease occurs throughout the year. In my series it prevailed in greatest number in July, August, and September. The incidence is shown in Table 3 and graphically presented in fig. 2.

TABLE 3.—*Seasonal incidence.*

Month.	Cases.
January	3
February	2
March	1
April	8
May	7
June	9
July	39
August	42
September	40
October	8
November	2
December	3

A study of Table 3 indicates that there was a gradual increase in the number of cases admitted to the hospital from April to September, the largest number having occurred during

July, August, and September, after which the number of cases decreased.

It is interesting to learn why there are so many cases of bacillary dysentery in Manila from July to September.

There seems to be a good deal of evidence to show that it is due to the seasonal conditions prevailing in those months. In the Philippines the wet season usually begins in May, following the hot season, and from July to September a great deal of rain falls, as a rule. The rainy season, then, is favorable to the spread of the virus, by water and especially by flies, because the fallen rain affords them many breeding places. Flies are more abundant during the wet season.

Flies are carriers of pathogenic organisms, on account of their mode of life; they alight and feed on fæcal matter and then, their bodies infected, again alight on food. Bahr,(1) in Fiji Islands, observed many cases of bacillary dysentery during the wet season.

Furthermore, other diseases, such as typhoid fever, amœbic dysentery, etc., the epidemiology of which points to flies as the carriers of the infecting microorganisms, are also prevalent in Manila during the rainy season.

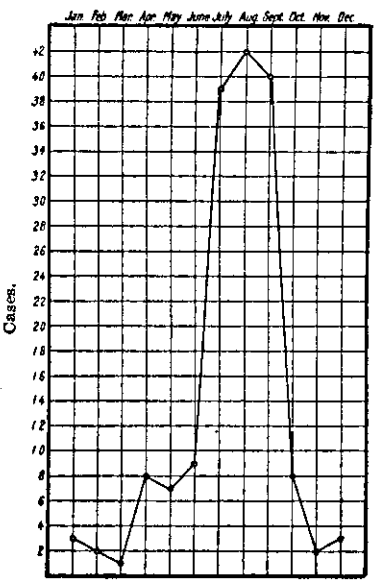

FIG. 2. Showing seasonal incidence.

BACTERIOLOGY

It was established many years ago that the etiologic factors of the disease are the various strains of *Bacillus dysenteriæ*. In the epidemic of 1918 Shiga infection was prevalent. Out of 66 cases in which cultures were made from stools 30 cases were Shiga; 7, Flexner; types undetermined, 14; negatives, 15, or 22.72 per cent. The percentage, then, of positive cases is 77.28, while Cowan's and Miller's(2) Alexandria cases gave 41.2 per cent positive.

MORBIDITY AND MORTALITY

It is an established fact that of all the types of *Bacillus dysenteriæ*, the Shiga-Kruse type is the most toxic. It is the deciding factor in influencing the mortality, especially if the

disease is allowed to run many days without adequate treatment. Among patients belonging to the laboring class, who disregard their ailments during the first days of disease and who have low resistance because of their unhygienic mode of living and deficient diet, morbidity is naturally high and mortality correspondingly so. The patients that I have handled were mostly of the laboring class.

Let me state, however, that it was impossible to obtain an adequate supply of serum; consequently it became necessary to select the most serious cases for the administration of serum and to deny the benefits of such treatment to those who did not seem to be very ill. Even in some of the serious cases we were compelled to discontinue the treatment owing to lack of serum.

In addition to the handicap just mentioned, it should be stated that, on admission to the hospital, most of these charity patients were in bad condition. Many of them remained in their homes from three to seven days without any treatment and applied for admission only when the disease had already made much progress, and thus were suffering from severe toxæmia and marked involvements of the larger gut. In many cases they collapsed on admission. In such exceptional cases the use of serum is not efficacious.

With the application of the serum the mortality rate is from 9 to 12 per cent, according to Shiga;(9) Rosenthal, in Russia, has obtained 5.1 per cent; Bahr,(1) in Fiji Islands, obtained 1.8. Of the one hundred sixty-four patients suffering from dysentery who were admitted during 1918 to the medical wards of the Philippine General Hospital fourteen died, giving a mortality rate of 8.53 per cent. Of the one hundred five who received anti-dysenteric serum twelve died, giving a mortality rate of 10.47 per cent.

Without the use of the serum, there is distinct increase in the mortality rate, as was observed in the Philippine General Hospital in the fiscal year 1912–1913. During this period the death rate among one hundred ninety-one males and seventy-five females amounted to 17.8 and 20 per cent, respectively.

According to Musgrave and Sison,(8) the mortality rates in hospitals in other countries, where treatment with drugs is practiced, are as follows:

	Per cent.
Japan	16.5 to 30.2
Singapore (1902)	25.4
Ceylon (1903)	28.4
Hongkong (1902)	37.3

VARIOUS METHODS OF TREATMENT

In my series various methods of administering the serum were used; namely, (1) per rectum alone, (2) intramuscular injection and per rectum (enema), (3) intramuscular injection alone, (4) intramuscular and intravenous injection, (5) intravenous injection alone.

CLASSIFICATION

To classify the disease exactly under each type, as to whether a case is severe or mild, is not an easy task. The custom of using the number of stools for the basis of classification as to severity is in my opinion oftentimes very misleading. For instance, a case with few bowel movements will be classified naturally as mild; but such cases are not always mild. It has been frequently observed by me that patients are admitted to the department who have few bowel movements but are in very weak general condition, in a stuporous state, and who show subnormal temperature and weak pulse. To place such cases in the same category with mild ones is not justifiable. I emphasize this because many of my deaths were from this type. The worst kind of dysentery is that in which there are few bowel movements, low temperature, and weak pulse. It may be that the toxin acted as antiperistaltic on the digestive tract, as pointed out by Fisher.(4) The severity of toxæmia and the general condition of the patient should, in my opinion, be the basis for classifying the disease as of the severe or of the mild type.

FIRST SERIES

Serum per rectum alone.—This method consists of introducing the serum through a long rubber tube, one end of which is provided with a funnel. The patient is in the knee-chest position. The serum is to be given high, and to be retained a long time—the longer the better. Before the serum is given, preliminary preparation of the patient should be observed. A cleansing enema of sodium bicarbonate (1.5 per cent) is given, to be followed by another enema of 60 to 100 cubic centimeters of starch solution with 15 drops of laudanum, so as to diminish the irritability of the intestines. The high serum enema can then be given half an hour after the starch enema.

Under this method I was able to treat nine cases who were not very sick, whose general condition was good. The fever was not high, and the bowel movements were from 10 to 25 in twenty-four hours. My dosage varied from 30 to 80 cubic centimeters of

serum daily, although it can be given in greater amount and more frequently without any danger. In many instances the serum could not be retained long; in such event another serum enema should be given. These nine cases all recovered.

SECOND SERIES

Serum per rectum and intramuscular injection.—In this series I was able to apply the combined method (per rectum and intramuscular) in ten cases, all severe; there were two deaths giving a mortality rate of 20 per cent. All these cases were very severe on admission.

THIRD SERIES

Intramuscular injection alone.—This series comprised sixty-four patients who were all classified as of the severe type. There were five deaths, giving a mortality rate of 7.81 per cent. The usual site of injection is the buttock. The dosage employed was from 20 to 60 cubic centimeters daily, depending upon the severity of the case and the supply of serum. Later, however, I employed the dosage of 20 cubic centimeters every four hours for the first three days after admission, and 20 cubic centimeters twice a day thereafter. I found this method very efficacious.

FOURTH SERIES

Intramuscular and intravenous injection.—In the fourth series I was able to try this combination (intramuscular and intravenous) on thirteen cases, all very severe, some collapsed; five cases died, giving a mortality rate of 38.46 per cent. One case died twelve hours after the intravenous injection. This particular case was in a state of collapse before the serum was given. The other four cases died from two to four days after the administration of serum intravenously.

FIFTH SERIES

Intravenous injection alone.—This method was tried on nine cases, all severe and two collapsed. All these cases recovered. The dosage employed was 10 to 20 cubic centimeters daily, 1 cubic centimeter being injected four to six hours previously so as to avoid anaphylaxis.

The intravenous method should be done under rigid asepsis. The place of injection is usually the anterior cubital fossa where the veins are commonly prominent. It is done in closed method. There is great difficulty, however, in performing the closed

method on collapsed patients, as the veins are also collapsed. In my collapsed cases the open method was resorted to. The reaction following intravenous injection was mild; usually there was a chilly sensation lasting from thirty to sixty minutes, accompanied by rise in temperature, with slight acceleration of pulse and respiration. The reaction may last from ten to fifteen minutes, followed by thirst and general weakness. The temperature may fall by crisis or by lysis after the next twelve hours.

DISCUSSION

The main point that I would like to emphasize in the treatment of bacillary dysentery is the early and broad application of the biological products whenever possible. In an acute disease like this one, early application of specific therapy is imperative on account of the definite pathological lesions taking place progressively in the large intestines, and because of the severe toxæmia that arises after absorption of the toxins. It should be given even to cases in which there is suspicion of bacillary dysentery, without waiting for the results of the bacteriological examination. This is highly advisable in cases of infection in children, for they have lower powers of resistance, and they die comparatively sooner than adults. The earlier the serum is given the better, as frequently very good results follow early treatment.

It has been observed by those who have studied the disease carefully that the toxins of the organisms act selectively on the mucosa of the large intestine. Injections of dysenteric toxins into susceptible animals produce similar symptoms, as well as the specific pathological changes in the large intestine, that are observed in human beings. This agrees with the observations of Shiga, Flexner, and Sweet and Doerr. Doerr(3) was able to save the life of an animal, after administering a lethal dose of the dysenteric toxin, by a previous injection of serum. Similar observations by Todd, Vaillard, and Dopter confirm their findings. Shiga,(9) the pioneer in this field, states that dysenteric serum is bactericidal as well as antitoxic.

In view of the established facts, set forth by qualified observers, the local use of the serum seems to my mind not to be unscientific. Considering well the morbid changes in the large intestine, where acute inflammation and ulceration are taking place, and recalling that that is the site where the virus flourishes best, continuously elaborating the toxins, we can

see at once the working basis for the use of the local application of serum. As it has been found that the serum is both antitoxic and bactericidal, its administration would mean, then, the neutralization, locally, of the unobserved toxins and the decreased vitality of the virus, if not its actual death.

Clinical observations seem to support this view. Twenty-four hours after the administration of serum per rectum, the patient feels a marked alleviation of the subjective symptoms;

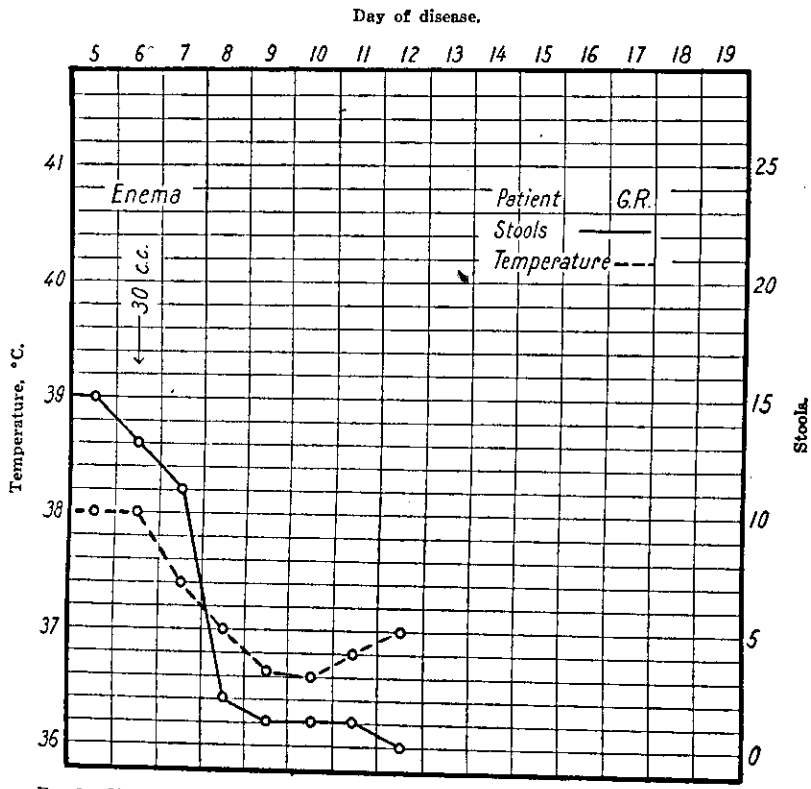

FIG. 3. Showing the response of the patient to the administration of the serum per rectum (enema). Patient G. R.

the colicky pain is diminished, as well as the tenesmus; stools decrease in number; and the temperature is lower. During succeeding days the stools become less bloody and mucoid, then feculent, and then of soft consistence (see fig. 3).

I am fully aware of the drawbacks to this method. The serum may not reach the whole area of tissue involved; it may fail to neutralize the toxins already absorbed in the system; or it may not be retained properly by patients whose intestines are very irritable.

This method is of great advantage only when the patient is able to retain the serum for a long period. I know specific cases in which patients could retain it for from two to four hours, if previously given a high enema of starch solution with laudanum. In case of intramuscular injection in patients whose bowel movements have already diminished, the serum per rectum works well because the serum, being retained for a longer

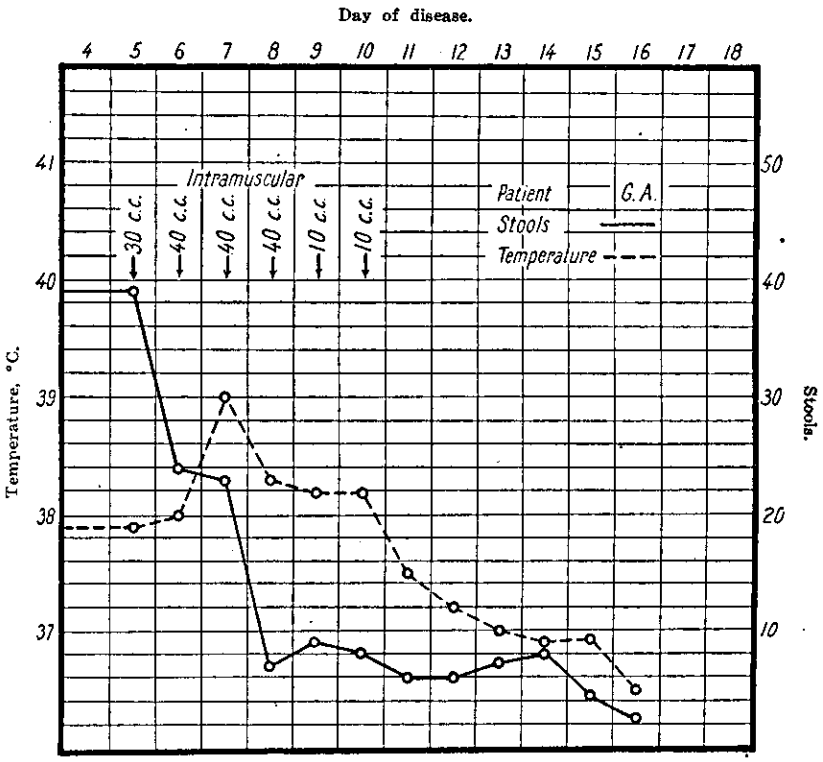

FIG. 4. Showing the effect of serum administered intramuscularly and per rectum (enema). Patient G. A.

period in the lumen of the gut, is absorbed in greater amount. Many patients prefer this method because it is not painful.

The rationale of the administration of serum by intramuscular injection can readily be seen. The main purpose is to neutralize the toxin as much as possible by specific antibodies which are present in the serum. The results are gratifying. If the serum is given, the patient, formerly restless, becomes quiet, the temperature gradually falls, the colicky pain and tenesmus are less severe, and the stools decrease in number. These results may be observed in the twenty-four to forty-eight

hours following injection. Where there has been collapse the pulse becomes fuller and stronger a few hours after the injection. There is marked abatement of the subjective symptoms on succeeding days. In my experience it seems that the combination of intramuscular injection and serum enema in acute cases is advisable because we combat the disease from two sides; namely, by direct neutralization of toxin in the blood, and by

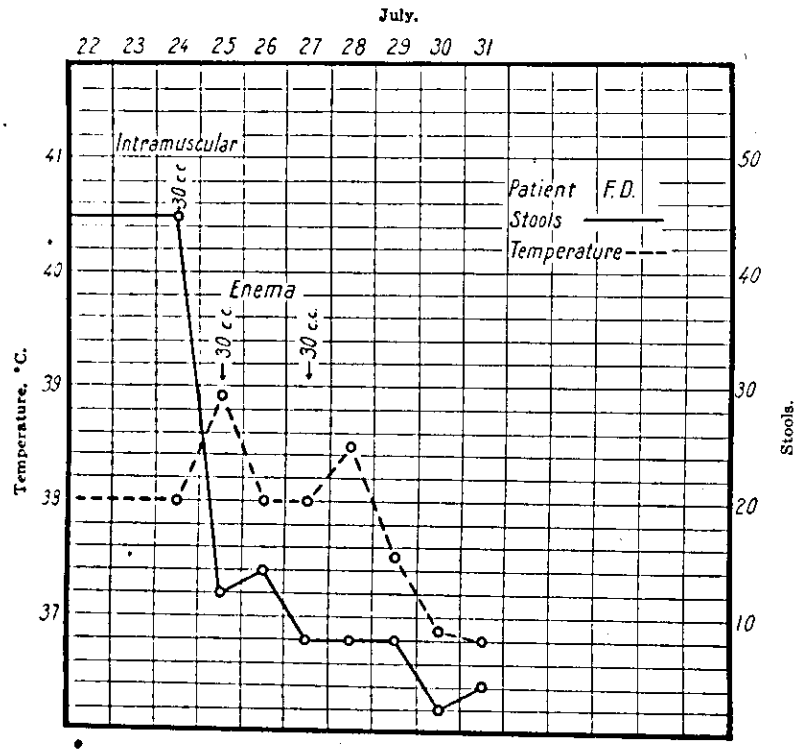

FIG. 5. Showing the effect of serum administered intramuscularly and per rectum (enema). Patient F. D.

direct action of the serum on the bacteria and their poisonous products in the large intestines (see figs. 4 and 5).

The action of the serum introduced intravenously is similar to that of the intramuscular injection except that the effects are more rapid. The special indication of this method is in very severe cases, where injection is followed by marked alleviation of the subjective symptoms; the pulse becomes fuller and stronger a few hours after the injection; restlessness diminishes and the general appearance becomes brighter in the next twenty-four hours. Marked improvement of the objective symp-

toms follows after the next day. The intravenous injection is usually followed by a chilly sensation which may last thirty minutes, and is accompanied by rise of temperature.

Although I have observed no accident so far, such as sudden death following just after the intravenous injection, or symptoms of embolic formations, the possibility that such may occur under certain conditions should not be overlooked. The treatment should therefore be given with great prudence and caution.

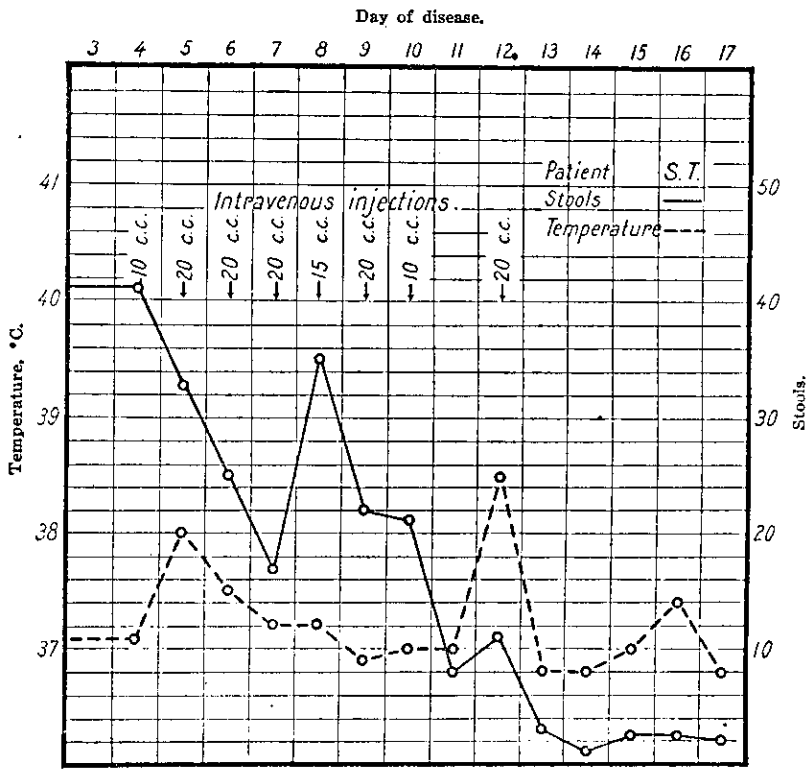

FIG. 6. Showing the effect of serum administered intravenously. Patient S. T.

An example of the results of intravenous injection is seen in fig. 6.

Aside from the specific action of the serum in the treatment of this disease, its nonspecific action should also be considered.

When the serum is introduced into the body it may act as a foreign protein, stimulating the body to produce nonspecific substances. The production of nonspecific substances as the result of the use of foreign protein has been considered seriously in the treatment of typhoid fever(6) and of arthritis.(7) In

the case of bacillary dysentery these nonspecific substances might be produced, especially when the serum is given intravenously, and some of the beneficial effects that were obtained might be due to them.

COMPLICATIONS

In this series of one hundred five cases treated with serum, no symptoms have been observed referable to serum sickness. Lately, however, I have observed in three cases certain bad symptoms of which the serum might have been the cause.

The first case was an adult, a healthy and robust man. He received two intramuscular injections of 20 cubic centimeters of serum with an interval of twenty hours between injections. One hour after the second injection, the patient felt very weak, became restless, had subnormal temperature, cold perspiration, and small, rapid pulse. Breathing increased in rate. He died twenty-four hours after the onset of these symptoms.

The second case was a female nurse. She is a fairly developed, healthy woman. She developed urticarial rash all over her body, accompanied by sudden rise of temperature, and pain in the joints, more marked in the extremities and the jaws; so much so that she could hardly open her mouth or move her extremities. She was receiving the serum intramuscularly, 20 cubic centimeters daily, and the symptoms were observed on the eighth day. She recovered.

The third case was also a female nurse. She is a very well-developed, very stout woman. For four days she was receiving 20 cubic centimeters of serum intramuscularly daily. Two and a half hours after the last injection, she felt very weak, became restless, moaned continuously, and had subnormal temperature, cold extremities, cold perspiration, and weak and rapid pulse. She remained in this condition for twelve hours, after which time she gradually recovered.

CONCLUSIONS

The serum can be employed in a variety of ways; namely, per rectum alone (enema); intramuscularly; intravenously; in combined form, as per rectum and intramuscularly, etc.

The use of the serum per rectum (enema) is as yet limited; it produces beneficial effects in certain cases when the intestines become less irritable after starch enema with laudanum. The intravenous method produces immediate effects (better than the intramuscular injection), but should be used with great caution, for there is danger of subsequent embolic formations

under certain conditions. The combined method (serum per rectum and intramuscular injection) has given just as good results as any method of administering the serum, and is safer than the intravenous method.

Finally, the serum acts in a specific manner, but at the same time it may act as a foreign protein, producing nonspecific antibodies. Above all it must be given early, even in cases where bacillary dysentery is only suspected, in order to produce good results.

ACKNOWLEDGMENTS

To Prof. Ariston Bautista, chief of the department of medicine, University of the Philippines, I acknowledge sincerely my high obligations for placing at my disposal all the material available in the department; also to Dr. Otto Schöbl and Dr. C. S. Pañganiban, of the Bureau of Science, who prepared the serum and made the bacteriological examinations of the stools for me.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Illustrating the age incidence by decades.
2. Showing seasonal incidence.
3. Showing the response of the patient to the administration of the serum per rectum (enema). Patient G. R.
4. Showing the effect of serum administered intramuscularly and per rectum (enema). Patient G. A.
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6. Showing the effect of serum administered intravenously. Patient S. T.

UNSYMMETRICAL ADDITION TO THE DOUBLE BOND, I: A THEORY OF THE REACTION MECHANISM OF THE DIRECT UNION [1]

By GRANVILLE A. PERKINS

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SIX TEXT FIGURES

Certain difficult problems in organic chemistry, such as those of the chemical changes in living organisms, cannot be solved without much more definite knowledge of the mechanism of chemical reactions than is available at present. Remarkable advances have been made recently in the theory of valence and the nature of the binding forces between atoms, but it does not appear that any organic chemist has applied these new conceptions toward revising the older theories of the mechanism of reactions.

The theories of Thiele,[2] Vorländer,[3] Michael,[4] and Nef,[5] were founded on Kekulé's hypothesis of "affinity units." According to this hypothesis in its simple form, a reaction involving the main uniting forces between atoms can take place only when preceded or accompanied by a rupture of the bonds of the original compounds. This was supposed to take place symmetrically, as follow:

$$A—B \text{ gives } A— + —B.$$

Observing, however, that A—B in general reacts quite unsymmetrically, these investigators merely amended the hypothesis, the favorite amended form being:

$$A^-—B^+ \text{ gives } A^-— + —B^+.$$

Even with all possible amendments, the hypothesis proved entirely inadequate [6] for the formation of any definite and con-

[1] Received for publication March 15, 1921.

[2] Thiele, J., Ann. d. Chem. 306 (1899) 87 et al.

[3] Vorländer, D., Ann. d. Chem. 341 (1905) 1 et al.

[4] Michael, A., Ber. deut. chem. Ges. 39 (1906) 2138 et al.

[5] Nef, J. U. Ann. d. Chem. 298 (1897) 202 et al.

[6] Cf. Vorländer, D., Ber. deut. chem. Ges. 36 (1903) 3529, "Der Körper *x* hat an und für sich weder eine bestimmte Wertigkeit noch eigne Valenzen."

sistent theory of the mechanism of reactions. The difficulty was the ancient one of putting "new wine in old bottles."

There has been a strong tendency in the last two decades to refer everything unexplainable to "tautomerism," which has been used as a convenient hypothesis allowing one to manufacture as many structures as he desires for a compound. The result has naturally been a mass of confusion, from which there was only one way of escape, namely, the one clearly indicated half a century ago by Kekulé [7] himself, when he emphasized the fact that his formulas were nothing but *rational* formulas, and that true *constitutional* formulas could be obtained only through physical research. Although physicists cannot yet tell us the exact proportions or the exact forces in atoms, they can tell us much. It seems that the time is now at hand when the Kekulé affinity units may be, with due respect for what they have accomplished, laid on the shelf and replaced by more definite conceptions.

RECENT CONCEPTIONS OF CHEMICAL AFFINITY

Ever since the discovery of electrons it has been apparent that they are connected intimately with atomic union. A certain form of union between atoms (the salt-forming union) was easily explained as due to the transfer of an electron from one atom to another. While such an interpretation proved very valuable to inorganic chemists in dealing with this type of union, it was found to be no advance over the older form, $A^-—B^+$, in dealing with the type of union predominant in organic chemistry, which may be called the direct union. No satisfactory electronic conception of the direct union had been proposed until Lewis [8] advanced his hypothesis of the "cubical atom," which was later developed and made more definite by Langmuir [9] as the "octet theory of valence."

THEORY OF REACTION MECHANISM OF THE DIRECT BOND

On the basis of Langmuir's octet theory of valence it seems possible to revise the older theories of reaction mechanism into a much more tangible and consistent form. For the sake of definiteness, and because physicists disagree concerning force laws at small distances, it is necessary to put in the form of definitions

[7] Kekulé, F. A., Ann. d. Chem. 106 (1858) 147.

[8] Lewis, G. N., Journ. Am. Chem. Soc. 38 (1916) 762.

[9] Langmuir, I., Journ. Am. Chem. Soc. 41 (1919) 868, 1543; 42 (1820) 274. For the notation and nomenclature used cf. Perkins, G. A., Philip. Journ. Sci. 19 (1921) 1.

certain assumptions which Langmuir and others [10] have made concerning the force acting on shell electrons. To these will be added several suppositions which seem to the writer reasonable from a physical standpoint and necessary from a chemical standpoint.

DEFINITIONS

Elastic constraints.—When an external influence acts on an unshared electron in shell C of a compound, A—B—C, moving it from its position of equilibrium, an elastic constraint, or force of restitution, is developed, opposing the motion. This force

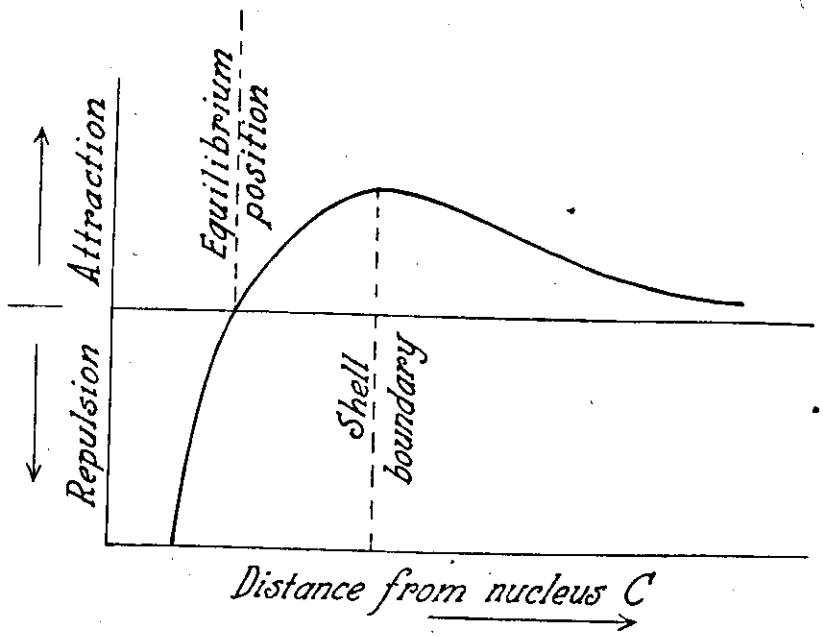

FIG. 1. Forces of restitution acting on an unshared shell electron, upon radial displacement.

does not vary in accordance with Hooke's law; in fact, it may be somewhat discontinuous, but it shows *approximately* the variation shown in fig. 1.

At the present time we cannot accurately resolve this total constraint into its components. It is sufficient for the present purpose to note that this constraint is made up of forces attribut-

[10] Concepts similar to some of these definitions can probably be found in J. Stark's "Electrizität im chemischem Atom," Leipzig, 1915, a book not available to the author at present. Stark was the first to propose any approximately satisfactory electronic conception of the direct bond, but his theory fails to take account of the very important unshared electrons.

able to each nucleus and electron in the compound A—B—C, and therefore any shift of any of the electrons in the compound, or of nucleus A or B, will cause a slight displacement of the position of equilibrium of the electron in question. For calculating the direction and relative amount of such displacement we may tentatively apply the ordinary laws of electrostatics, but *only to the mutual repulsion of electrons.*

When an electron is shared by two shells, as an electron shared by C and D in the compound A—B—C—D—E—F, it is con-

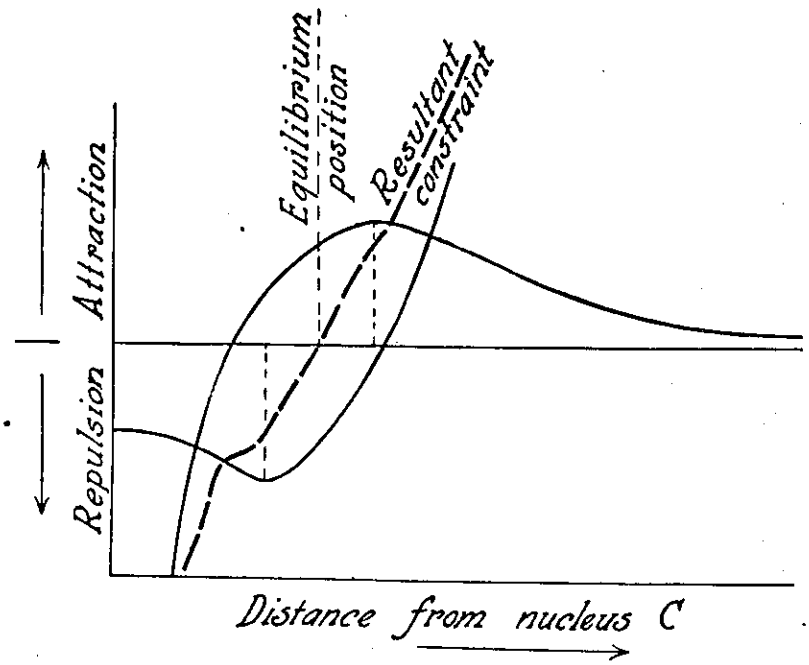

FIG. 2. Composition of forces of restitution acting on a shared electron.

venient to consider its constraint to be the resultant of two *single* constraints of the nature just described. One of these originates in A—B—C—, and the other in —D—E—F. The composition of two single constraints is shown in fig. 2.

Shell boundary.—It is convenient to consider that, when an electron is moved beyond the point where its constraint toward the nucleus reaches a maximum, it is *dissociated* and no longer inside the shell. Accordingly the points of maximum radial single constraint constitute a *dissociation boundary.* This boundary obviously has meaning only in reference to a certain specified electron or pair of electrons. For certain purposes there seems to be an advantage in extending the idea to a *shell*

boundary, composed of sections, each section being defined in reference to the pair of electrons which it contains. The exact shape of such a shell boundary cannot be determined without more knowledge of the forces involved than is available at present, but the boundary of an ordinary four-pair shell is probably roughly tetrahedral with very rounded corners.

Loosely or firmly held electrons.—An electron whose position of equilibrium is well within a shell boundary requires a relatively large external force to move it even a small distance, and

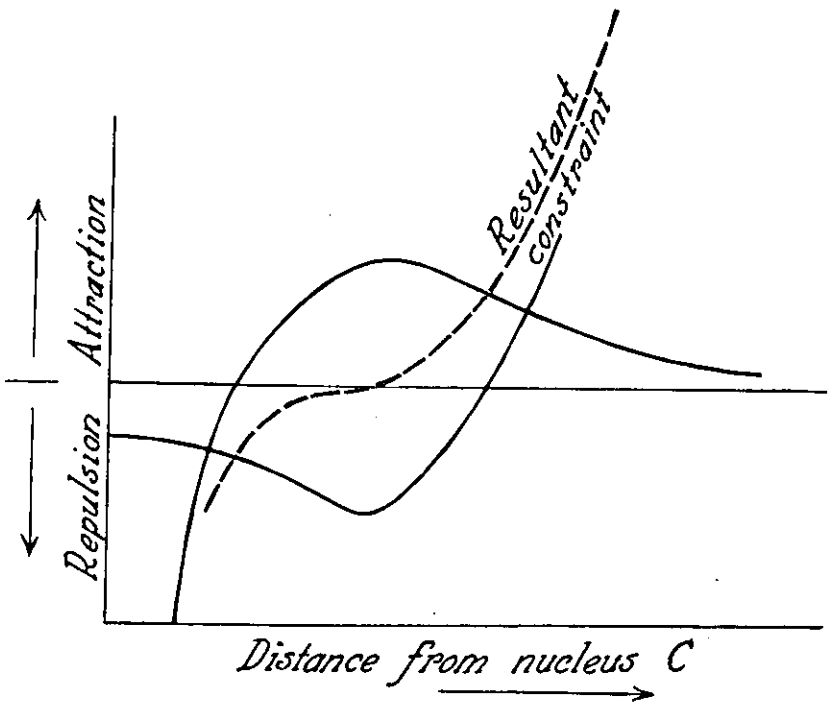

FIG. 3. Symmetrically weak union; loose electron.

will be spoken of as firmly held. A shared electron near the boundaries of both shells requires a much smaller force to move it the same distance, and will be spoken of as loosely held (see fig. 3). Such an electron is easily removed from either shell, both because it is near the boundary and because its constraint is slight.

The distribution of electrons in a shell.—The final solution of this problem has not yet been reached by physicists. As a convenient working hypothesis shell electrons will be considered to be ring-shaped magnetons,[11] which have sufficient magnetic at-

[11] Parson, A. L., Smithsonian Misc. Coll. 65 (1915) No. 11.

traction so that in the shells of the inert atoms they are in direct contact with each other.[12] In the shells of the other atoms, however, it seems that the nuclear attraction is insufficient for such close union, and they separate, forming a larger, looser shell, but still have a strong tendency to form pairs. In the case of unshared electrons this tendency may not be effective, but when external influences concentrate electrons toward certain portions of the shell, pairs are formed.

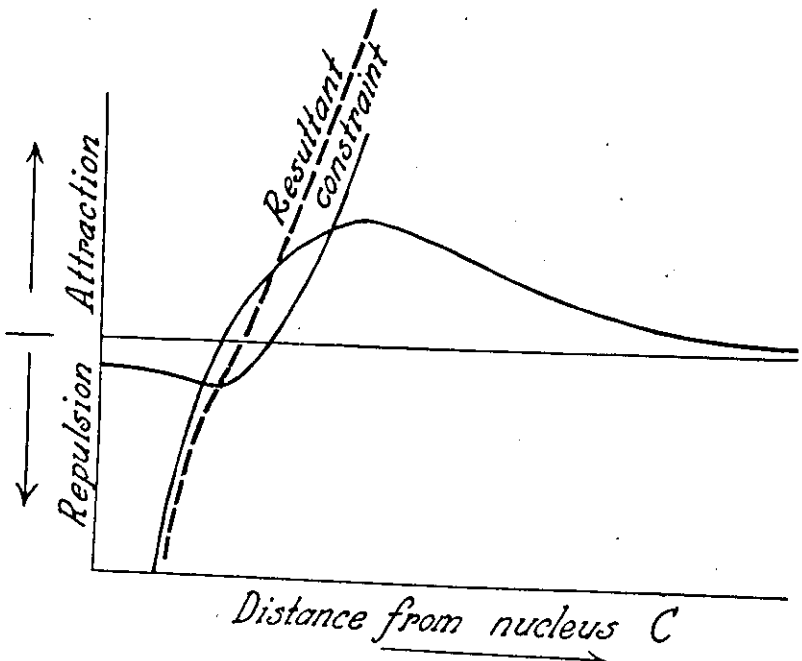

FIG. 4. Unsymmetrical weak union; firm electron.

Forces uniting atoms.—If we consider the forces represented in figs. 2, 3, and 4 to be only the components of constraint in a direction parallel to the line joining nuclei D and C, then the intercept on the "equilibrium position" line of either "single constraint" line is the force with which the electron in question unites the two atoms. Considering the atoms to be at equilibrium distance, the binding forces of this and any other electrons which C and D may be sharing are exactly neutralized by other forces, which may be considered as one force; namely, the mutual repulsion of the two atoms. Therefore the strength of union is measured, not by the *amount* of this binding force, but

[12] Cf. Perkins, G. A., Philip. Journ. Sci. 18 (1921) 325, 19 (1921) 21.

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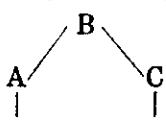
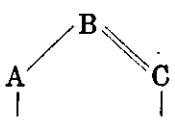
by the rapidity with which it increases when the atoms are pulled apart. If, in the equilibrium position, the binding electrons are far within the shell boundaries of both C and D, the union is a strong one. If the binding electrons are close to the boundary of *either* C or D, the union is weak, and easily broken. This may be easily verified by noting that if the shells in figs. 3 and 4 are pulled apart the binding force increases only very little and then rapidly decreases.

The single bond.—When two shell boundaries intersect, each of the shell electrons near the intersection is drawn, by the foreign nucleus, toward the line joining the two nuclei. That is, there is an effective concentration of electrons toward the portion common to both shells. Any number of electrons from one to six may be thus drawn into the common portion and serve as binding electrons between the two atoms. When electrons are thus concentrated, however, the magnetic tendency to form pairs becomes strong, so that the union with two shared electrons is very stable as compared to the union with one shared electron. Therefore, the latter has not been recognized as a chemical union, and the former has been called a single bond.

According to the above hypothesis as to the distribution of electrons, in the single bond the electrons are in contact (probably in "figure-eight" formation) and in a plane perpendicular to the line joining the two atoms.

The benzene bond.—According to the writer's view of the structure of benzene and similar compounds, the bond composed of three binding electrons is stable under certain conditions. The principal condition is that three atoms should be held rigidly with the lines joining their nuclei at an angle (in the case of carbon, for example, 120°); that is, between those favoring the formation  (109°), and the formation,  (125°). The special cases in which this bond is very stable will be discussed in a later paper. Ordinarily it has an instability comparable with that of the one-electron bond and the five-electron bond.

The double bond.—When the concentrating forces mentioned above bring four electrons into the common portion of two shells, it seems that magnetic forces are strong enough to form two

pairs (probably figure-eights) but not enough to bring these pairs together.

The pairs have strong constraints toward their normal positions in each shell, so that independent rotation of the atoms is difficult, and probably impossible without dissociation.

The lateral displacement of the electrons causes large electron-free spaces, mentioned below in connection with direct addition. The radial displacement, caused by the increased repulsion of the atomic kernels at the closer approach demanded by the double bond, brings the electrons nearer to the shell boundaries than in the ordinary single bond. Consequently a double bond, or at least one-half of it, is more easily broken than a single bond.

The triple bond.—The triple bond, with three pairs of electrons, is extremely unstable, due to the extensive displacements of the electrons from their normal positions. The formation of acetylene and similar compounds at high temperatures is by no means a contradiction of this statement.

Dissociation.—When two atoms are bound by a pair of electrons whose position of equilibrium is near the boundary of one of the shells, only a slight thermal shock is necessary to cause the electrons to leave this shell entirely and take up a new position in the other shell. It sometimes happens that the electrons are near enough to the boundaries of *both* shells so that one electron goes to each shell. Due to the magnetic stability of a pair of electrons, however, and because bonds weak enough to dissociate are usually quite unsymmetrical, the result in nearly all cases is that both of the electrons go to the shell which attracts them most strongly, leaving two vacancies in the weak shell. The usual result, therefore, of the dissociation of A—B is not A— + —B as assumed in the affinity unit hypothesis, but $A^{+} < {}^{-}B$. This is the fundamental point on which the writer's theory differs not only from the older theories of reaction mechanism but also from any of the recent ones that have come to his attention. It appears to be a reasonable deduction from Langmuir's octet theory, but the importance of it in organic chemistry seems to have escaped notice. Attempts to apply electronic conceptions to organic reactions have resulted in little advance over the older theories because of the assumption of dissociation in the manner $A^{+} - + - B^{-}$, which does not explain the observed facts in the case of the direct bond.

Direct addition.—The shell boundaries above defined have reference only to the removal of electrons from a normal shell,

or the reverse, namely, addition of electrons to an *incomplete* shell. The addition of electrons to a complete shell occurs in a certain type of reaction, which may be called the *direct addition* type.

In general, two separated molecules attract each other by a force which is usually called cohesion, but which Langmuir [13] has shown to be so closely related to the forces of primary chemical union that it should be considered a "secondary valence" force (possibly even a primary valence force in the case of salt-like compounds).

As two molecules approach each other this attraction increases to a maximum, and then, becoming neutralized by a repulsion, falls off to zero. In this equilibrium position the two molecules

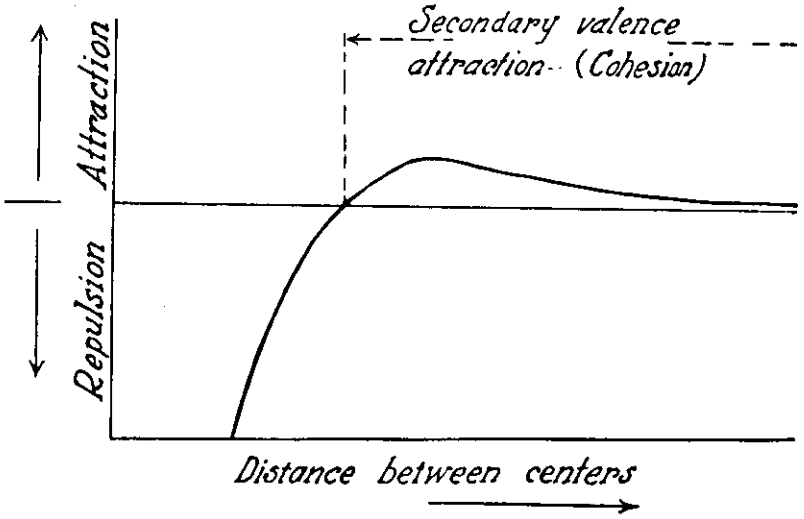


FIG. 5. The attraction between two non-reacting molecules.

are usually not sufficiently close for any interpenetration of shells. Such a union between molecules is identical with Kekulé's *idea* of a "polymolecule," but many of the compounds considered by Kekulé to be of this type are actually direct union compounds. In the case of direct union compounds the secondary valence forces are usually very weak, a typical example being the forces which hold together in a crystal the molecules of a paraffine hydrocarbon. The variation of force with distance in such a case is shown in fig. 5. It is here assumed that each molecule is free to rotate. The attraction, being chiefly elec-

[13] Langmuir, I., Journ. Am. Chem. Soc. 38 (1916) 2221, 39 (1917) 1848.

trostatic and due to the distribution of charges on each molecule, is of course entirely dependent on the orientation of each molecule in reference to the other.

If two molecules are capable of reaction, but only when assisted by thermal impact, the attractive force will be of the nature shown in fig. 6. This figure illustrates well the particular type of reaction under consideration, namely, that of direct addition to an already complete shell. Such reactions are usually dependent on thermal impact, and the molecules show a maximum repulsion at a certain distance (fig. 6, *a*). Direct addition reactions not dependent on thermal impact do not have a repulsion at this distance, but in all probability have a minimum attraction.

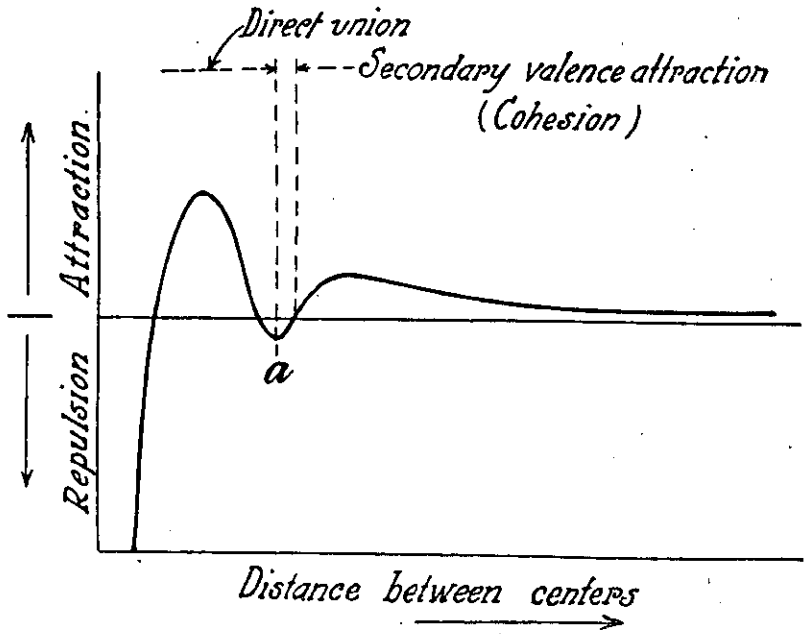


FIG. 6. The attraction between two reacting molecules.

Since the sharp rise to the left of point *a* in fig. 6 is due to the interpenetration of electron shells, we may conveniently consider that just at this distance of maximum repulsion (or minimum attraction) entrance of one or more electrons into a shell of the foreign molecule takes place. This definition makes possible a concept of shell boundary from the point of view of direct addition, which varies however according to the molecule added. The extension of this definition of shell boundary to the process of addition to an incomplete shell is unnecessary,

because an adequate concept has already been provided, and impossible, because usually no minimum attraction point *a* exists.

Addition to an already complete shell is possible only when the electrons are so displaced from their normal positions as to leave *large electron-free spaces* in the shell. When such direct addition occurs, the resulting molecule is unstable, and usually[14] immediately rearranges so as to reduce the number of electrons in the shell to the normal value.

TWO TYPES OF DIRECT BOND REACTION

Most of the reactions of organic chemistry involve both addition and dissociation. These are divided into two types:

Type 1.—Direct addition reaction.

Type 2.—Dissociation-addition reaction.

In type 1 there is evidence that addition of electrons to a shell, as above defined, takes place before dissociation. In type 2 there is evidence that dissociation occurs before addition. The dissociation is usually, but not always, of the unsymmetrical type.

REACTIONS OF THE DOUBLE BOND

As has been intimated, it seems to the writer that the primary cause of double bond reactivity is no more or less than was suggested by Baeyer,[15] namely, that a double union between two atoms cannot exist without a distortion of the binding mechanism (the electron shell) of each atom. In fact, some so-called "double bonds" exist only in the half dissociated condition, $\overset{\diagdown\,\diagup}{A}{}^{+} - B^{-}$ (better $\overset{\diagdown\,\diagup}{A} \propto B$). An illustrative case of each of the two types of double-bond reaction will be briefly considered.

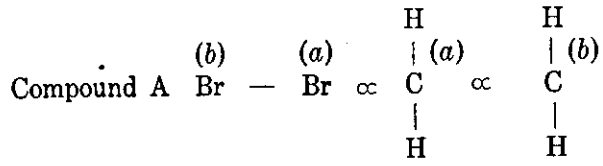
TYPE 1. DIRECT ADDITION REACTION

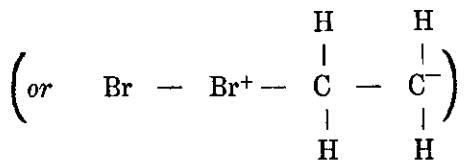
In the case of the addition of bromine to ethylene and similar reactions it seems to the writer that various assumptions which have been made as to directed valence, tautomerism, opened up force fields, or ionization, are unnecessary to explain the observed facts. It seems more probable that thermal impacts, aided by the slight attraction between the positive and negative areas of the respective molecules, occasionally send a bromine molecule

[14] Sometimes conditions prevent this rearrangement. Cf. Langmuir's discussion of liquid PCl_5. Langmuir, I., Journ. Am. Chem. 41 (1919) 919.

[15] Baeyer, A., Ber. deut. chem. Ges. 23 (1890) 1275.

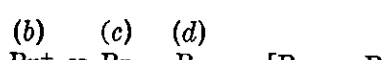
against an ethylene molecule with sufficient force so that some of the bromine shell electrons momentarily penetrate into one of the large empty spaces in the shell of one of the carbon atoms, *a*. Such an addition loosens (by repulsion) the restraints on shell *a* electrons sufficiently so that the other carbon atom, *b*, immediately pulls a pair of the shared electrons beyond the boundary of shell *a*. The result is:





This compound has never been isolated, so far as the writer knows. A large number of exactly analogous unstable intermediate products, however, have been isolated. Vorländer,[16] who found it impossible to explain them on the basis of "affinity units," named them class "A" compounds, and the rearranged stable forms, class "B." These designations will be adopted by the writer.

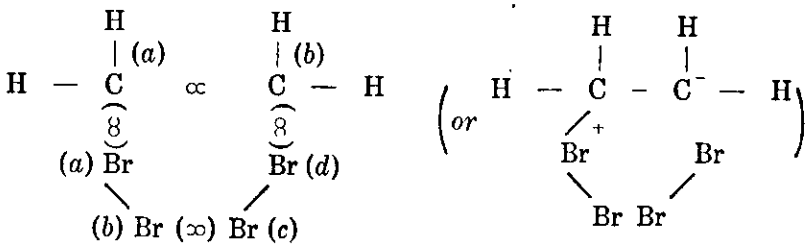
In this case the "class A" compound is very unstable for the reason that when bromine *a* "lends" a pair of electrons to carbon *a*, a general electron shift (toward the right in the formula as shown), away from bromine *b* and toward carbon *b*, takes place notwithstanding the relatively strong attraction which the bromine kernel has for electrons. The strained condition of electron-free spaces originally on carbon *a*, is thus transferred to bromine atom *b*. The next step is probably that another bromine molecule acts on bromine *b*, just as bromine *a* did on carbon *a;* forming a positive bromine ion,



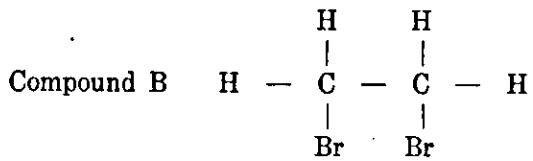
This ion is immediately attracted by the negatively charged carbon *b*, upon which one of its atoms is deposited by a repetition of the same type of reaction. The movements involved at

[16] Ann. d. Chem. 341 (1905) 1.

this stage are more electronic than atomic, as a six-membered ring is easily formed:



When the electrons have moved to their stable positions a molecule of bromine splits off, leaving ethylene bromide:



According to the view just outlined, a double bond is inherently reactive. There are influences, however, which cause this property of reactivity to vary in different compounds.

The formation of addition products of class A is assisted by two factors (1) and (2), and checked by a third (3). The most important of these is (1):

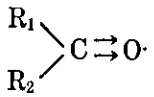
(1). Any influence increasing the size of the electron-free areas in the shell attacked.

(2). Any influence shifting the double bond electrons nearer the boundary of the attacked shell.

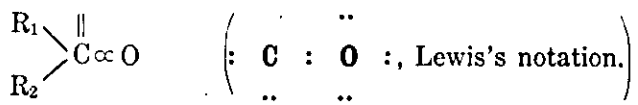
(3). Steric hindrance, limiting effective impact of the intruding molecule.

TYPE 2. DISSOCIATION-ADDITION REACTION

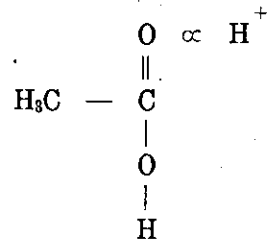
In such cases as the esterification of acetic acid and alcohol, there is a very polar double bond:



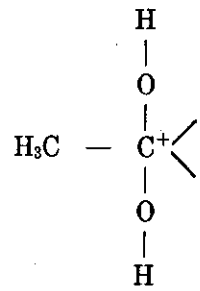
Thermal impacts, even when unassisted by catalysts, are able to cause a small proportion of the molecules to be half dissociated into the form:



When the reaction is catalyzed by $-H^+-$, the acetic acid is directly attacked, forming:

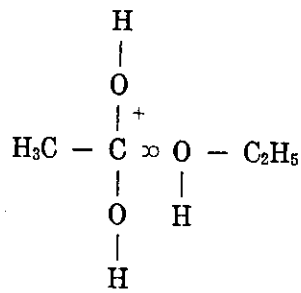


in which the electrons of the double bond are drawn forcibly away from the carbon atom. It is therefore a very reasonable assumption that a large number of these catalyzed molecules take the half-dissociated form:



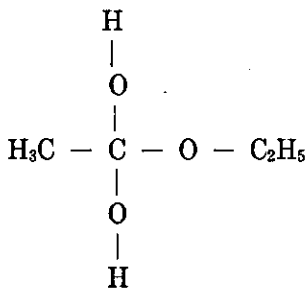
It is to be noted that the carbon atom becomes very unsaturated, having now two vacancies in its shell. It therefore is very reactive, and an addition product with alcohol is formed:

Compound A



Again the first compound is unstable. The accumulation of positive charge near the alcohol oxygen releases the attached hydrogen as $-H^+-$ giving:

Compound B



Further discussion of this reaction, including the subsequent stage of regeneration of the double bond, will be postponed to a later paper. It is sufficient for the present to point out the influences which cause this type of reactivity to vary in different compounds. The reaction does not depend on large spaces in the undissociated shell, but only on dissociation, so that factor (2) mentioned above is primarily important. Factor (3) is relatively unimportant, and factor (1) has no influence.

CONCLUSION

The discussion of the two typical reactions has been very brief, the purpose of this paper being to present a hypothesis, not to justify it. The hypothesis is admittedly in a rough form, and doubtless will require certain additions and modifications of the less-important details. Nevertheless it forms a definite and consistent basis for many of the various "rules" and "principles" that have been applied to organic reactions, in so far as they are consistent with the facts, and is particularly valuable in dealing with the "exceptions" to these rules, among which may be considered the benzene nucleus. The writer expects to take up some detailed applications in a series of papers, but before continuing this series the subject of one-electron and three-electron bonds, not provided for in Langmuir's postulates, will be considered.

SUMMARY

1. A theory of the reaction mechanism of the direct union is proposed, based principally on Langmuir's octet theory of valence.

2. The distinct features of the theory are certain working definitions of the electronic forces and the suppositions (*a*) that dissociation of the direct bond usually takes place in such a

way as to leave one of the atoms saturated and the other with two unsatisfied bonds; and (*b*) that in a certain type of reaction an atomic shell momentarily contains two more electrons than its normal number.

3. The two main types of double bond reactions have been illustrated.

4. The applications of this theory will form the subject of a series of papers.

ILLUSTRATIONS

TEXT FIGURES

G. 1. Forces of restitution acting on an unshared shell electron, upon radial displacement.
2. Composition of forces of restitution acting on a shared electron.
3. Symmetrically weak union; loose electron.
4. Unsymmetrical weak union; firm electron.
5. The attraction between two non-reacting molecules.
6. The attraction between two reacting molecules.

CHAROPHYTA FROM ANNAM AND GUAM

By JAMES GROVES
Of Yarmouth, England

NITELLA ACUMINATA Braun.

A form with the size and habit of *Nitella flexilis*, but with small, rather dense heads; secondary rays fairly long. It has well-developed, usually geminate, ripe fruit; the oöspore is golden-brown, about 275 μ long, 225 μ broad, 175 μ thick, showing about 8 ridges with flanges and a distinct crest; membrane with minute granular decoration.

Indo-China, Annam, Nhatrang and vicinity, *C. B. Robinson 1342*, March 11 to 26, 1911.

NITELLA DUALIS Nordstedt.

The female plant with well-developed fruit; the oöspore is golden-brown, about 180 to 200 μ long, 150 to 160 μ broad, 100 μ thick, showing 6 or 7 low ridges; membrane with netted decoration, the meshes about 5 μ in diameter. The fruiting whorls are enveloped in dense mucus. Though the dactyls (= ultimate rays) are 2-celled, the allantoid form of the upper cell shows the relationship of the plant with the most extreme members of Braun's section Polyarthrodactylae, rather than with the species placed by him under Diarthrodactylae. The dactyls with their almost mucronate points to the upper cells correspond with Nordstedt's figures of the original plant and, although the oöspore is smaller, its shape and the decoration of the membrane agree with the description. Unfortunately, the specimen is not a satisfactory one owing principally to having been floated out on harsh coarse-fibered paper rendering it well-nigh impossible to detach the slender sterile branchlets intact, but the dactyls of these as well as those of the fertile branchlets appear to be uniformly 2-celled. The original specimens of *Nitella dualis* came from Liberia, West Africa, and so far as I know it had not hitherto been found elsewhere, so that Doctor Robinson's discovery of it in Annam is of great interest.

Indo-China, Annam, Nhatrang and vicinity, *C. B. Robinson 1506*, March 11 to 26, 1911.

CHARA AUSTRALIS R. Brown.

A rather small form with numerous well-developed fruits and antheridia. The characteristic black cylindric-ellipsoid oöspore is about 550 to 650 μ long and 400 μ broad, and shows 7 or 8 strong ridges. This is an important extension of the known range of this species, which has hitherto only been recorded from Australia, Tasmania, New Zealand, New Caledonia, Fiji Islands, and (?) Tahiti.

Indo-China, Annam, Nhatrang and vicinity, *C. B. Robinson 1167*, March 11 to 16, 1911.

CHARA FLACCIDA Braun.

This has the ripe oöspore, when viewed entire, of a transparent golden-brown, the character which serves to distinguish *Chara flaccida* from *C. gymnopitys* Braun. Braun and Nordstedt in "Fragmente Monogr. Charac." record *C. flaccida* from the Marianne Islands and Celebes. Nordstedt, in his account of the Characeae collected by the *Gazelle* expedition, refers to *C. gymnopitys* being found in both localities. If the two species are distinct, they must be very closely related.

Marianne Islands, Guam, *R. C. McGregor 592*, October, 1911. The same locality, December, 1911, *No. 191* (no collector's name).

THE PHILIPPINE WASPS OF THE SUBFAMILY SPHECINÆ

By S. A. ROHWER

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The wasps belonging to the subfamily Sphecinæ are often called "thread-waisted," because of the petiolated abdomen. The habits and prey of the group vary considerably. The Chlorionini nest in the ground and provision their nests with Orthoptera. The Sphecini also nest in the ground but use lepidopterous larvæ as food for their young. The Sceliphronini are usually called "mud-daubers," because of their habit of constructing mud nests which are provisioned with spiders.

The group is easily recognized by the three complete cubital cells; petiolate abdomen; long propodeum, in which the spiracles are well removed from the base; the presence of two calcaria on intermediate tibiæ; rather large size; etc.

Key to the Philippine tribes of the subfamily Sphecinæ.

1. Second and third cubital cells each receiving a recurrent vein; propodeum without a U-shaped area on its dorsal surface; robust species with a short petiole..... Chlorionini.
   Second cubital cell receiving both recurrent veins; slender forms with a long petiole..... 2.
2. Propodeum without a U-shaped area on its dorsal surface; female with a tarsal comb..... Sphecini.
   Propodeum with a U-shaped area on its dorsal surface; tarsal claws with an inner tooth; female without a tarsal comb..... Sceliphronini.

Tribe CHLORIONINI

Genus CHLORION Latreille

The species of this genus were monographed by Kohl in 1890 under the generic name *Sphex* and they are still often assigned to that genus, which is however properly applied to species assigned to *Ammophila*.

Key to Philippine species of the genus Chlorion.

1. Tarsal claws with one inner tooth..... 2.
   Tarsal claws with two inner teeth..... 3.

2. Body entirely metallic blue or green..... **Chlorion lobatum (Fabricius).**
   Head and thorax reddish; abdomen metallic purplish.
   Chlorion splendidum (Fabricius).
3. Metanotum bituberculate..... 4.
   Metanotum not bituberculate or with a longitudinal sulcus..... 8.
4. Wings hyaline or mostly so; head and thorax with silvery pubescence.
   Ammobia umbrosa var. plumifera (Costa).
   Wings yellowish hyaline, with the apices smoky; pubescence black.
   Ammobia umbrosa var. rufipennis (Fabricius).
   Wings dark brown or blackish..... 5.
5. Legs black; wings blackish, with a distinct violaceous reflection; pubescence black..... 6.
   Legs at least partly reddish; wings brownish, without a distinct violaceous reflection..... 7.
6. Propodeum with a median furrow..... **Ammobia (?) maura (Smith).**
   Propodeum without a median furrow.... **Ammobia sulciscuta (Gribodo).**
7. Abdomen black; pubescence of head and thorax golden.
   Ammobia aurulenta var. lepeletierii (Saussure).
   Abdomen partly red; pubescence of head and thorax black.
   Ammobia aurulenta var. sericea (Fabricius).
8. Scutellum without a median sulcus; black..... 9.
   Scutellum with a distinct median sulcus..... 10.
9. Pubescence black; wings fuscous brown, with a coppery tinge.
   Ammobia (?) morosa (Smith).
   Pubescence pale, with a faint golden tinge; wings hyaline, with a dark spot apically..... **Isodontia severini var. philippensis var. nov.**
10. Wings yellowish..... **Ammobia luteipennis (Mocsáry).**
    Wings blackish..... 11.
11. Legs entirely black..... **Ammobia haemorrhoidalis var. mutica (Kohl).**
    Hind femora red.
    Ammobia haemorrhoidalis var. siamensis (Taschenberg).

Subgenus Chlorion Latreille

The two species of this subgenus that have been recorded from the Islands are not represented in the Philippine collections at my disposal. The record of *Chlorion splendidum* is open to question, and it may be well to eliminate this name from the list until specimens have been collected.

Chlorion (Chlorion) lobatum (Fabricius).

This beautiful species can be easily recognized by its metallic body.

Chlorion (Chlorion) splendidum (Fabricius).

This species has been recorded only in the Brown catalogue, and its occurrence in the Islands needs verification.

Subgenus Ammobia Billberg

Chlorion (Ammobia) umbrosa var. plumifera (Costa).

Chlorion umbrosus var. *plumiferus* Costa, WILLIAMS, Bull. Hawaiian Sugar Planters' Assoc. 14 (1919) 125.

This variety is included in many of the Philippine lists under the name (*Sphex*) *Chlorion argentata* Dahlbom. *Argentata* is a synonym of *umbrosa* and as there seems to be only one variety in the Islands which might be assigned this name, it is rather certain that references to the species apply to this variety rather than to the typical form.

LUZON, Manila (*W. A. Stanton*), female: Laguna Province, Los Baños (*Baker 369*). Two females and one male, under Bureau of Agriculture accession numbers, as follows: LUZON, Manila (*B. Arce*), accession No. 129: Bataan Province, Lamao, and Nueva Ecija Province, Cabanatuan (*C. R. Jones*), accession Nos. 843 and 1254.

Chlorion (Ammobia) umbrosa var. rufipennis (Fabricius).

Sphex umbrosa var. *rufipennis* Fabricius, KOHL, Ann. Naturh. Hofmus. Wien 5 (1890) 408; ASHMEAD, Proc. U. S. Nat. Mus. 22 (1904) 150.

Ashmead has recorded this variety as occurring in the Islands, but it is not represented in the collection before me. This variety can be recognized by the black pubescence and yellowish hyaline wings with smoky apices.

Chlorion (Ammobia?) maura (Smith).

Sphex maurus Smith, BINGHAM, Ann. & Mag. Nat. Hist. VI 16 (1895) 443; BINGHAM, Fauna Brit. India, Hym. 1 (1897) 247.

This species is recorded from Cape Engaño, Luzon, by Bingham but is not in the collection before me. From the descriptions the species is allied to *Ammobia sulciscuta* (Gribodo) but may be separated from it by the presence of a median furrow on the propodeum. The following characters from Bingham's description should aid in the identification of the species: "Black with black pubescence; the wings dark fuscous, with a rich purple effulgence," scutellum, metanotum, and propodeum furrowed down the middle; propodeum steeply rounded at apex, almost truncate, "the median furrow not reaching the edge of the truncation, but broadening out in spoon-shaped form just before the margin."

Length of male, 25 to 28 millimeters; of female, 28 to 34 millimeters. Tarsal claws with two teeth.

Chlorion (Ammobia) sulciscuta (Gribodo).

Sphex sulciscuta GRIBODO, Miscel. Ent. 2 (1894) 2.

A single male collected at Los Baños, Laguna, Luzon (*E. M. Ledyard 1024*) agrees with Gribodo's description, which is based on the female, except in regard to the clypeus, and it seems likely that this difference is sexual. The species very closely resembles *mutica* (Kohl) but is readily separated by the bilobed metanotum.

Uniformly black, with black pubescence; wings violaceous; face with silvery pile beneath the black hair; clypeus flat, the anterior margin broadly and shallowly emarginate.

Length, 26 millimeters.

Chlorion (Ammobia) aurulenta (Fabricius).

Sphex aurulenta Fabricius, KOHL, Ann. Naturh. Hofmus. Wien 5 (1890) 382; BINGHAM, Fauna Brit. India, Hym. 1 (1897) 250.
Sphex ferruginea LEPELETIER, Hist. Nat. Ins. Hym. 3 (1845) 345.
Sphex lineola LEPELETIER, Hist. Nat. Ins. Hym. 3 (1845) 353.

I have followed the synonymy as published by Kohl in 1890 for this species. Certain of the lists of Philippine Chlorionini have treated *ferruginea* and *lineola* as distinct varieties. Bingham, 1897, uses the name *lineola* for a variety which has the pubescence of the head and thorax silvery white; but he is evidently wrong, as the original description of *lineola* gives the color of the pubescence as golden. It is possible that what Bingham had as *lineola* is the variety *pallidahirta* Kohl and that Kohl's variety should be added to the Philippine list. Only two varieties are represented in the collections before me.

Chlorion (Ammobia) aurulenta var. lepeletierii (Saussure).

Chlorion aurulentus var. *ferrugineus* Lepeletier, WILLIAMS, Bull. Hawaiian Sugar Planters' Assoc. 14 (1919) 124.

LUZON, Laguna Province, Los Baños (*Baker 368*), female.

Chlorion (Ammobia) aurulenta var. sericea (Fabricius).

This variety has been recorded from Manila by Kohl (1890) and is represented in the collection before me by two males received from C. F. Baker.

LUZON, Laguna Province, Los Baños, Mount Maquiling (*Baker 2729*).

Chlorion (Ammobia?) morosa (Smith).

Sphex morosus Smith, BINGHAM, Ann. & Mag. Nat. Hist. VI 16 (1895) 443; BINGHAM, Fauna Brit. India, Hym. 1 (1897) 246.

In 1895 Bingham recorded as doubtfully belonging to this species a female collected at Cape Engaño, Luzon, by Whitehead,

but in 1897 he states that the female of this species is unknown. It is possible therefore that the name "*morosus*" should be excluded from the list of Philippine Chlorionini. I do not know the species and have taken the following characters from Bingham's 1897 description of the male:

Claws with two teeth; scutellum and metanotum without a median sulcus; petiole of the abdomen long, slightly curved upwards; propodeum "with a gentle rounded slope posteriorly, except the apex, where it is suddenly steep;" black, with black pubescence, the clypeus and face with dense silvery pile; "wings fuscous brown with a coppery effulgence, the hind wing much lighter and paler." "A variety has the posterior femora below and the inside of the posterior tibiæ red."

Chlorion (Ammobia) luteipennis (Mocsáry).

Sphex luteipennis Mocsáry, KOHL, Ann. Naturh. Hofmus. Wien 5 (1890) 423.

Chlorion luteipennis Mocsáry, WILLIAMS, Bull. Hawaiian Sugar Planters' Assoc. 14 (1919) 127.

LUZON, Laguna Province, Los Baños (*Baker*), female; Mount Maquiling (*Baker 2730*), male, also a female.

Chlorion (Ammobia) haemorrhoidalis (Fabricius).

Sphex nigripes Smith, KOHL, Ann. Naturh. Hofmus. Wien 5 (1890) 421; BINGHAM, Fauna Brit. India, Hym. 1 (1897) 248.

Sphex haemorrhoidalis Fabricius, TURNER, Ann. & Mag. Nat. Hist. VIII 10 (1912) 369.

Turner in 1912 pointed out that the correct name to use for this species is *haemorrhoidalis* rather than *nigripes*. The typical *haemorrhoidalis* is African; the Oriental forms, although they differ greatly in color, are classed as varieties.

Chlorion (Ammobia) haemorrhoidalis var. mutica (Kohl).

Ammobia mutica Kohl, WILLIAMS, Bull. Hawaiian Sugar Planters' Assoc. 14 (1919) 128.

LUZON, Laguna Province, Los Baños (*Baker 367, F. X. Williams 5*), females.

Chlorion (Ammobia) haemorrhoidalis var. siamensis (Taschenberg).

MINDANAO, Dapitan (*Baker 6842*), one male.

Subgenus **Isodontia** Patton

Chlorion (Isodontia) severini var. philippensis var. nov.

Female.—Length, 17 millimeters; length of anterior wing, 12 millimeters. Differs from Kohl's description of the species

in absence of the rufous markings of the abdomen (the narrow testaceous bands on the apical margins of the tergites are not wanting). Fuscous spot in the anterior wing confined to the area anterior of cubitus and beyond end of the radial cell.

Male.—Length, 14 millimeters; length of anterior wing, 10 millimeters. In Kohl's monograph of the species of this group [1] the male runs to *Isodontia diodon* Kohl but differs from that species in the color of the wings. From *Isodontia egens* Kohl, to which it seems allied, it may be distinguished by the longer third antennal joint. In the male the mandibles are slender, acute apically, and with an inner tooth near apex (almost bidentate apically); the outer margin is simple and not as in the female; distance between eyes below but little less than the combined length of the third and fourth antennal joints; eighth sternite with a broad, arcuate emargination medianly; antenna longer than head and thorax. Color and sculpture as in the female.

Type locality.—Puerto Princesa, Palawan.

Allotype locality.—Los Baños, Laguna, Luzon.

Type.—Catalogue No. 23635, United States National Museum.

Both specimens from C. F. Baker, the allotype under his No. 370.

Tribe SPHECINI

Genus SPHEX Linnæus

All of the Philippine species of *Sphex* belong to those subgenera which have the first two abdominal segments forming the petiole. No species of *Psammophila*, which has the petiole formed of the basal part of the first segment, has been recorded. The species now called *Sphex* were formerly assigned to *Ammophila* (a synonym of *Sphex*) and are better known under that name.

Key to Philippine species of Sphex.

1. Tarsal claws with two inner teeth near the base; large, black, with violaceous wings..... Sphex (Ceratosphex) bakeri sp. nov.
   Tarsal claws simple; wings fuscohyaline..... 2.
2. Frons normal, convex; dorsal part of pronotum with distinct transverse rugæ; scape of female reddish..... Sphex atripes (Smith).
   Frons deeply concave; dorsal part of pronotum without distinct transverse rugæ (in one specimen there are a few indistinct wrinkles); scape black in both sexes..... Sphex coronatus (Costa).

[1] Ann. Naturh. Hofmus. Wien 5 (1890).

Subgenus Sphex Linnæus

Sphex (Sphex) coronatus (Costa).

Ammophila coronata COSTA, Ann. Mus. Zool. Napoli 2 (1862–1864) 111.
Ammophila superciliaris SAUSSURE, Reise d. Novara, Zool. 2[1] Hymenoptera (1867) 24.

There seems no reason to doubt the above synonymy as both descriptions certainly apply to the species treated below. This species, although resembling *atripes* in general appearance, may readily be distinguished by the characters mentioned in the preceding key. The male is without red markings and shows very little variation, but the females vary some in the color of the legs and abdomen. Four females represent a variety in which the first two tergites are largely reddish and the tarsi almost entirely reddish. These color differences are not accompanied by any differences in structure. The structure varies somewhat, as certain specimens have a few rugæ on the side of the pronotum and there is some variation in the rugosity of the mesoscutum.

Typical females from: LUZON, Laguna Province, Los Baños (*Baker 372, 6844*): Bataan Province, Lamao (*C. V. Piper*), (*C. R. Jones*), accession No. 844, Bureau of Agriculture. Females of the color variety from: MINDANAO, Davao (*Baker 6845*); Dapitan (*Baker 3207*); Iligan (*Baker 3205*). PANAY, Antique Province, Culasi, June, 1918 (*R. C. McGregor*). Males from: LUZON, Laguna Province, Los Baños (*Baker 374*); Mount Maquiling (*Baker*); Bataan Province, Lamao (*C. R. Jones*), accession No. 840, Bureau of Agriculture. MINDANAO, Iligan (*Baker 3206*); Cagayan (*Baker 3820*).

Sphex (Sphex) atripes (Smith).

Ammophila atripes Smith, BINGHAM, Fauna Brit. India, Hym. 1 (1897) 229; ASHMEAD, Proc. U. S. Nat. Mus. 28 (1904) 150.

Ashmead and Brown seem to be the only ones to record this species from the Islands, and I doubt if their records were based on specimens. I have seen no specimens of *atripes* from the Philippines but have included the species in the above key so it can be identified if it occurs there and to point out certain differences between it and *coronata*.

Subgenus Ceratosphex novum

This subgenus can be readily distinguished from true *Sphex* by the presence of two teeth on the tarsal claws at the base beneath. It bears about the same relation to *Sphex* as *Para-*

psammophila does to *Psammophila*, and as a group has long been recognized, but no one seems to have given it a name. To me it seems that there is a distinct use for a name for such a group.

Genotype, *Sphex* (*Ceratosphex*) *bakeri* sp. nov. described below.

Sphex (Ceratosphex) bakeri sp. nov.

Female.—Length, 33 millimeters; length of the anterior wings, 20 millimeters. Robust; head somewhat wider than the thorax, narrowing behind the prominent eyes, mandibles large, with a large inner tooth somewhat before the middle; clypeus convex, with a shallow median impression before apex, the surface with large, well-separated punctures (except around impression), the apical margin truncate; inner margins of the eyes very slightly diverging below; frons shining, convex, parted by a median impressed line, with rather small, separated punctures; ocelli in a low triangle, completely surrounded by an impressed line; postocellar line distinctly shorter than the ocellocular line; vertex convex, with small separated punctures which are closer in the area behind the ocelli; third antennal joint but little shorter than the two following, apical joint truncate, subequal in length to the preceding; pronotum narrow, sloping anteriorly, with only small, widely scattered setigerous punctures; mesoscutum opaque, with close, rather small punctures; tegulæ polished; scutellum and metanotum convex, with irregular, longitudinal, raised lines; propodeum coarsely reticulate, laterally with a tendency to striate reticulations, sharply truncate posteriorly, the lateral dorsal area (behind the spiracle) with distinct transverse rugæ; mesepisternum with distinct, large, rather close punctures; legs strongly spined, the posterior basitarsus subequal in length to the two following joints; cubitella postfurcal; third cubital cell more than twice as long on radius as on cubitus; second abscissa of radius shorter than the first and also shorter than either the second or third abscissa of cubitus; second abscissa of cubitus somewhat shorter than the third; abdomen shining, the first tergite distinctly longer than the second; second tergite distinctly widening beyond the spiracles (that is, beyond middle). Black, with black pubescence; caudal margin of prothoracic tubercule fringed with white hairs; wings black, with a strong violaceous reflection.

Type locality.—Mount Maquiling, Laguna, Luzon.

Type.—Catalogue No. 23636, United States National Museum.

Described from one female received from C. F. Baker, for whom the species is named.

Tribe SCELIPHRONINI

Genus SCELIPHRON Klug

Many authors have considered that all the species belonging to this genus should be referred to one superspecific group, but I am inclined to agree with Dahlbom, Patton, and others and recognize two subgenera separated by certain structural characters and easily distinguished by color. Patton [2] was the first to point out the structural characters and at that time he used as genera the names *Pelopaeus* and *Chalybion*. Since then the blue species have usually been referred to *Chalybion*. Hutson [3] expresses the belief that this is wrong and that the name *Sceliphron* will have to be used for the metallic forms. He bases his opinion on recommendations *k* and *n* of the International Commission on Zoological Nomenclature and overlooks the designations of genotypes made by previous students. In 1810 Latreille designates the type of *Pelopaeus* as *spirifex* and in 1897 Bingham cites the same species as the type of *Sceliphron*. The species *spirifex* was included in the original account of both these genera, and both of the above type designations must be accepted as valid even if Bingham did not follow the recommendations (he violated no rules) of the International Code. *Sceliphron* Klug and *Pelopaeus* Latreille are isogenotypic and since *Sceliphron* is the older name Latreille's name will have to be placed in synonymy. This makes it possible to retain the name *Chalybion* for the metallic species.

Key to the subgenera of Sceliphron.

Black and yellow species; petiole usually about twice as long as propodeum; clypeus bilobed or bidentate anteriorly..... Sceliphron Klug.
Metallic blue species; petiole subequal with the propodeum; clypeus with more than two teeth..... Chalybion Dahlbom.

Subgenus Chalybion Dahlbom

The only species of this genus was originally described under the name *bengalensis* by Dahlbom and considered to be different from the European form, but more recent authors have synonymized the two and I have followed them.

[2] Proc. Boston Soc. Nat. Hist. 20 (1880) 378.
[3] Trans. Am. Ent. Soc. 45 (1919) 218.

Sceliphron (Chalybion) violaceum (Fabricius).

The few specimens of this species may be divided into two groups on the punctation of the frons, but it is probable that this will vary. More specimens should be studied.

LUZON, Manila (*Robert Brown*): Laguna Province, Los Baños (*Baker 379, 1290*), Mount Maquiling (*Baker 1351*): Rizal Province, Alabang (*B. Arce*), accession No. 1853, Bureau of Agriculture.

Subgenus Sceliphron Klug

Three species of this subgenus are represented in the Philippine material before me. One other has been recorded from the Islands, and in the following key I have tabulated it as well as certain other Oriental species. Those not recorded from the Philippines are preceded by an asterisk.

Key to certain Oriental species of Sceliphron.

1. Comparatively large species without yellow marks on thorax and with black pubescence; length about 27 millimeters ..... 2.
   Medium-sized species with yellow markings on thorax and with pale pubescence, length under 18 millimeters ..... 4.
2. Petiole and hind femora black ..... S. luzonensis sp. nov.
   Petiole and at least base of hind femora yellow ..... 3.
3. Hind femora and tibiæ marked with black ..... *S. intrudens Smith.
   Hind femora and tibiæ all yellow ..... *S. spinolae Lepeletier.
4. Petiole but little longer than the propodeum; apex of first tergite marked with yellow; scutellum yellow ..... S. deforme (Smith).
   Petiole twice or more than twice as long as the propodeum; postpetiole all black ..... 5.
5. Scutellum black ..... S. madraspatanum (Fabricius).
   Scutellum yellow ..... S. conspicillatum (Costa).

Sceliphron luzonensis sp. nov.

Sceliphron intrudens (Smith), var., WILLIAMS, Bull. Hawaiian Sugar Planters' Assoc. 14 (1919) 120.

This form is closely allied to *intrudens* and may ultimately be treated only as a subspecies. It is however as different as *spinolae*, and until the group can be treated from a study of material I prefer to treat the Philippine form as a species.

Female.—Length, 27 millimeters; length of anterior wing, 17 millimeters. Anterior margin of the clypeus with a deep, narrow, V-shaped median emargination, separating the broad, rounded, depressed lobes; frons with distinct, rather close punctures on a granular surface; a small area adjoining ocelli impunctate; ocelli in an equilateral triangle; postocellar line

slightly shorter than the ocellocular line; temples narrow; antennæ long, the third joint somewhat longer than the fourth; pronotum with close punctures, rather long, rounded, a longitudinal, median notch posteriorly; mesoscutum opaque, closely and finely striate-granular, the striations better defined posteriorly; scutellum and metanotum rather finely, longitudinally striate; propodeum with a broad, longitudinal furrow dorsally and with strong curved rugæ; posterior face of propodeum opaque, with strong transverse rugæ below; mesepisternum shining, with small, well-separated punctures; sides of propodeum longitudinally rugate; petiole cylindrical, about twice as long as propodeum; abdomen subglabrous, basally the apical segments subopaque with irregular longitudinal wrinkles. Black; scape and pedicellum rufo-piceous; apices of femora and the rest of the legs yellowish, the four anterior pairs faintly reddish; head and thorax with long black hair; wings yellowish hyaline; venation color of wings.

Type locality.—Mount Maquiling, Laguna, Luzon.

Type.—Catalogue No. 23637, United States National Museum.

Described from two females from C. F. Baker under his Nos. 1350 (type) and 6843.

Sceliphron deforme (Smith).

The name *deforme* has been synonymized with *formosum* by Bingham [4] but the Philippine specimens show so little variation and agree so well with the original description of *deforme*, and differ from the original description of *formosum*, that I have preferred to use the name *deforme* for them.

All the specimens before me are females. LUZON, Laguna Province, Los Baños (*Baker and Williams*); Mount Maquiling (*Baker*).

Sceliphron madraspatanum (Fabricius).

Sceliphron madraspatanum (Fabricius), WILLIAMS, Bull. Hawaiian Sugar Planters' Assoc. 14 (1919) 123.

This species has been recorded from the Islands by a number of authors but is not in any material I have seen from there.

Sceliphron conspicillatum (Costa).

Pelopaeus conspicillatus COSTA, Ann. Mus. Zool. Napoli 2 (1862) 1864, 112.

[4] Fauna Brit. India, Hym. 1 (1897) 239.

This form is readily separated from the preceding by the yellow scutellum. One of the specimens has the petiole entirely yellow but otherwise differs no more than the other specimens do among themselves. The propodeum varies from entirely black to having a yellow apical spot, or with an apical spot and two short lines on the disk.

LUZON, Manila (*Robert Brown*): Laguna Province, Bay (*P. L. Stangl*); Los Baños (*Baker 373*): Bataan Province, Lamao (*C. R. Jones*), one male, accession No. 1725, Bureau of Agriculture. LEYTE, Tacloban (*Baker*). PALAWAN, Puerto Princesa (*Baker 3821*), a variety with black petiole.

TWO NEW SPECIES OF PLANTS FROM HAINAN

By ELMER D. MERRILL
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From time to time in the past few years, botanical material from Hainan has been submitted to me by Miss Margaret M. Moninger, of the American Presbyterian Mission in Hainan, for identification. Much of the material has been collected in the vicinity of Kacheck and represents for the most part species of wide distribution, although with a fair percentage of endemic species. The two forms described below are apparently new.

GESNERIACEAE

TRICHOSPORUM Jack

TRICHOSPORUM MONINGERIAE sp. nov. § *Haplotrichium.*

Frutex glaber, ut videtur epiphyticus, usque ad 2 m altus; foliis oblongo-lanceolatis, in siccitate chartaceis, acuminatis, basi acutis, 7 ad 9 cm longis, usque ad 3 cm latis; inflorescentiis cymosis, terminalibus vel axillaribus, tenuiter longe pedunculatis, 5- ad 7-floris; floribus circiter 3 cm longis, calycis 5-partiti, laciniis elliptico-ovatis, obtusis, circiter 4 mm longis.

A glabrous, slender, apparently epiphytic shrub about 2 m high, the branches slender, terete, pale, the branchlets usually dark-olivaceous. Leaves apparently somewhat fleshy when fresh, when dry chartaceous, olivaceous, oblong-lanceolate, 7 to 9 cm long, 2.5 to 3 cm wide, subequally narrowed to the acuminate apex and to the acute base, the nerves slender, indistinct; petioles about 7 mm long. Cymes axillary and terminal, 5- to 7-flowered, their peduncles slender, 8 to 10 cm long, the branches 2 or 3, about 5 mm long. Bracts elliptic-ovate, about 5 mm long. Flowers orange-red, their pedicels 10 to 18 mm long. Calyx 5-parted, the lobes nearly free, elliptic-ovate, rounded, about 4 mm long. Corolla about 3 cm long, glabrous outside, very sparingly pubescent inside, somewhat curved, 5 to 8 mm wide when flattened, the mouth somewhat oblique, the lobes ovate, obtuse, about 8 mm long. Ovary glabrous, stipitate, including the short style about 2 cm long. Stamens exserted, the filaments slightly pubescent.

HAINAN, Loh-hoe, *Miss M. M. Moninger 188*, January, 1921, in the mountains, altitude about 400 meters.

Although the fruits are unknown, this species apparently belongs in the section *Haplotrichium*, and in this section is one of the very few species with broad obtuse calyx segments. It is further characterized by its slenderly long-peduncled, few-flowered cymes.

RUBIACEAE

GARDENIA Ellis

GARDENIA STENOPHYLLA sp. nov.

Species G. augustae (Linn.) Merr. (G. floridae Linn.) affinis, differt foliis anguste lanceolatis ad lineari-lanceolatis, 4 ad 8 cm longis, 4 ad 10 mm latis.

An erect glabrous shrub about 1 m high, the branchlets slender, grayish. Leaves narrowly lanceolate to linear-lanceolate, 4 to 8 cm long, 4 to 10 mm wide, subcoriaceous, olivaceous, shining, equally narrowed to the cuneate base and the blunt-acuminate apex; lateral nerves 9 to 13 on each side of the midrib; petioles up to 3 mm long, or leaves subsessile. Flowers white, fragrant, solitary. Calyx tube about 1 cm long, 5-ridged, base cuneate, the lobes narrowly lanceolate, in anthesis about 12 mm long. Corolla tube slender, 4 cm long, cylindric, the lobes spreading, oblong-obovate, inequilateral, 2.5 cm long. Fruits narrowly ellipsoid, about 2 cm long, crowned by the persistent erect calyx lobes, which in fruit are about 1.8 cm long and 1.5 mm wide.

HAINAN, Loh-hoe, *Miss M. M. Moninger 152*, May, 1919, in flower: KWANGTUNG PROVINCE, Yamchow, *K. K. Ts'oong 1916= Canton Christian College 3777*, June 6, 1918, with the local name *muk ak tsz*.

This species grows on river banks and is closely allied to the common *Gardenia augusta* (Linn.) Merr., differing essentially in its very narrow leaves.

Beccari [1] has discussed the stenophyllous plants of Borneo listing species of the genera *Croton, Nauclea, Tetranthera, Antidesma, Pinanga, Osmoxylon, Arundina, Garcinia, Erycibe, Eugenia, Psychotria, Saurauia,* and *Millettia* which occur along the banks of rivers and torrents. In the Philippines, in addition to representatives of some of the genera Beccari lists, we have species of *Randia, Buxus, Atlantia,* and *Excoecaria* growing in similar habitats and presenting similar stenophyllous

[1] Nelle foreste di Borneo (1902) 523.

characters. Our stenophyllous species grow on rocky banks and in the crevices of ledges in places subject to brief and sudden inundations by swiftly running water. In such habitats it is highly probable that the important cause of stenophylly is the fact that the various species, all shrubs and often small in size, have become adapted to the habitat from the effect of periodic brief inundations, as broad-leaved shrubs cannot long persist in such habitats. *Gardenia stenophylla* presents another example of the adaptation of a species to this peculiar habitat. It might better, perhaps, be considered merely as a variety of *Gardenia augusta*, its chief distinguishing character, the very narrow leaves, being due to its habitat.

THE DISSOCIATION OF HEXAPHENYLETHANE FROM THE VIEWPOINT OF THE OCTET THEORY OF VALENCE

By HOWARD IRVING COLE

Chemist, Bureau of Science, Manila

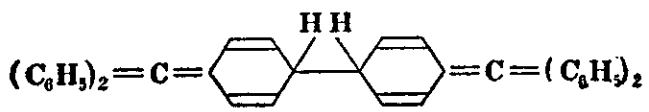
HISTORICAL

Gomberg,[1] in attempting to form hexaphenylethane by subjecting triphenylchlormethane to the action of metals, obtained a hydrocarbon possessing the requisite composition for hexaphenylethane, but its remarkable activity and its unsaturated character presumably precluded it from actually being this compound. He expressed the opinion that this was an instance of a compound with one atom of carbon in the trivalent state; that is, triphenylmethyl $(C_6H_5)_3 \equiv C$, a free radicle.

The original argument against the triphenylmethyl formula was that the determination of the molecular weight gave a dimolecular compound. This fact, however, was partly discounted later by the determination of the molecular weight in naphthalene at elevated temperatures (79° to 80° C.), the values found being lower than those in other solvents.

Markownikoff[2] in 1902 held in favor of the hexaphenylethane formula but assumed that the latter was extremely unstable. He gave no reason for this instability.

Heintschel[3] suggested the following formula as explaining the yellow color in solution:



Vorländer[4] thought that triphenylmethyl, dimolecular, was in some way different from the actual hexaphenylethane, which, if prepared, he believed would turn out to be stable.

[1] Gomberg, M., Journ. Am. Chem. Soc. 22 (1900) 757; Ber. deutsch. chem. Ges. 33 (1900) 3150.

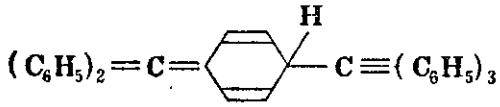
[2] Markownikoff, Journ. Russ. Phys. Chem. Soc. 34 (1902) 140.

[3] Heintschel, E., Ber. deutsch. chem. Ges. 36 (1903) 320.

[4] Vorländer, D., Ann. d. Chem. 341 (1905) 1.

The hexaphenylethane constitution was upheld by Chichibabin.[5] He put forward the instability of trimethylene and its homologues as an analogy for the instability of hexaphenylethane.

Jacobson [6] gave the following constitution to the compound:



Flurscheim [7] was in favor of a hexaphenylethane, unstable, partly broken down into $(C_6H_5)_3 \equiv C$.

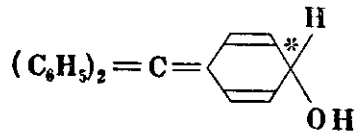
Up to this time one of the chief arguments for an unstable hexaphenylethane was the fact that neither the unsymmetrical tetraphenylethane nor the pentaphenylethane had been prepared. Hence the argument that these compounds were unstable, and from analogy hexaphenylethane was also unstable.

When Gomberg and Cone [8] finally prepared unsymmetrical tetraphenylethane and pentaphenylethane and found them to be fairly stable, the argument of analogy which had previously indicated the instability of hexaphenylethane now indicated its stability.

Gomberg [9] then showed that the color formation of the sulphates and chlorides of triphenylcarbinol is intimately connected with the change of the benzenoid to the quinoid form. He says:

> Furthermore since the manifestation of color and the salt-like properties of these substances are also simultaneous, the conclusion seems warranted that both of these phenomena are results of one and the same cause; i.e., tautomerization to the quinoid state. Consequently these salts were named quinocarbonium salts corresponding to the hypothetical quinocarbonium base:

$$(C_6H_5)_3 \equiv C\text{-}OH$$



> For obvious reasons the basicity was now assumed to lie in the quinone nucleus in the C * and not in the central carbon atom as had been originally supposed.

[5] Chichibabin, A. E., Ber. deutsch. chem. Ges. 37 (1904) 4709; Journ. f. prak. Chem. 74 (1906) 340.

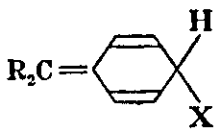
[6] Jacobson, P., Ber. deutsch. chem. Ges. 38 (1905) 196.

[7] Flurscheim, B., Journ. f. prak. Chem. 71 (1905) 505.

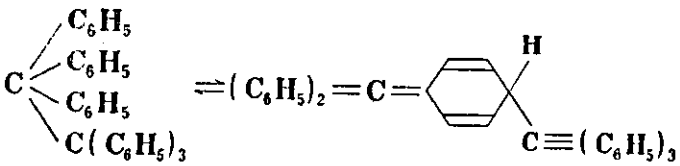
[8] Gomberg, M., and Cone, L. H., Ber. deutsch. chem. Ges. 39 (1906) 1461.

[9] Gomberg, M., and others, Ber. deutsch. Chem. Ges. 40 (1907) 1847, 1860; Journ. Am. Chem. Soc. 33 (1911) 540; Ann. d. Chem. 370 (1909) 190; 376 (1910) 208; Ber. deutsch. chem. Ges. 42 (1909) 406.

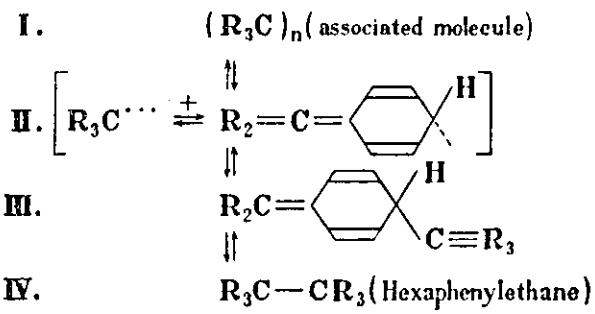
Later a number of the carbinols themselves were found capable of existing in the quinoid state as well as in the benzenoid state.[10] These and other experiments led Gomberg to conclude that (1) triphenylmethyl in solution behaves as if it had the quinol structure, either as a temporary base or as one in equilibrium with some other phase; (2) compounds of the type $R_3C{-}X$ possess the tendency to tautomerize to the quinoid modification:



(3) since the nature of the group X may apparently vary within wide limits then, as a corollary to the second conclusion, it follows that hexaphenylethane, considered as a triphenylmethane derivative, may also possess the tendency to tautomerize and give rise to a compound of quinol composition:



Gomberg now suggested an explanation which embraces all of the factors concerned: (1) the unsaturated character of triphenylmethyl; (2) the existence of the two, colorless and colored, modifications; (3) the dimolecular state in solution; (4) the probability of the quinollike structure; (5) the possible existence of an unstable hexaphenylethane:



[10] Journ. Am. Chem. Soc. 35 (1913) 1035.

Schmidlin [11] in 1908 observed that solutions of the colorless solid are at first colorless but that they acquire color after standing a few seconds. He was able to show that the colorless triphenlymethyl is only partially converted into the colored modification and that even in solution the two modifications exist in equilibrium with each other. He also showed that the colored form was more reactive.

Schlenck [12] in 1910 gave a new impetus to the trivalent carbon theory by preparing analogues of triphenylmethyl containing diphenyl groups. The determination of the molecular weights of these compounds showed some of them to exist largely in the monomolecular form. The colored modifications of triarylmethyls are monomolecular, some even in the solid state, as, for instance, tribiphenylmethyl.

Piccard,[13] Schmidlin,[14] and Schlenk and Mair,[15] using different methods, came to the conclusion that all solutions of hexaphenylethane contain monomolecular triphenylmethyl, the amount of this in benzol at 80° C. reaching 25 to 30 per cent of the whole amount of the hydrocarbon dissolved.

PRESENT THEORY

The various theories as to the structure of the triarylmethyls cited above tend in the right direction but have been befogged by our old affinity unit conception of valence. The epoch-making articles by Langmuir [16] on the arrangement of electrons and atoms in the molecule have made possible an entirely new conception of the mechanism of organic reactions which leads to a consistent explanation of the constitution and the chemical and physical properties of the triarylmethyls. The coexistence of two or more modifications of a triarylmethyl as shown, for example, by molecular weight determinations, can now be explained more clearly than by the indefinite term tautomerism.

In the following discussion the Lewis-Langmuir theory of valence will be applied to this problem along the lines suggested by Perkins,[17] whose nomenclature will, in general, be followed.

[11] Schmidlin, J., Ber. deutsch. chem. Ges. 41 (1908) 2471.

[12] Schlenck, N.; Weickel, T. U.; Herzenstein, A., Ann. d. Chem. 372 (1910) 1; Ber. deutsch. chem. Ges. 43 (1910) 1753.

[13] Piccard, J., Ann. d. Chem. 381 (1911) 347.

[14] Schmidlin, J., Ber. deutsch. chem. Ges. 45 (1912) 3180.

[15] Schlenk, W. u. Mair, L., Ann. d. Chem. 394 (1912) 179.

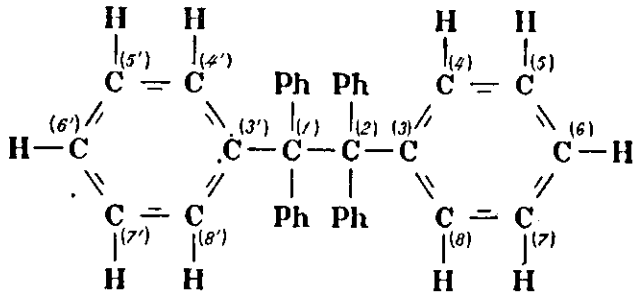
[16] Langmuir, I., Journ. Am. Chem. Soc. 41 (1919) 868, 1543; 42 (1920) 274.

[17] Perkins, G. A., Philip. Journ. Sci. 19 (1921) 325.

Lewis's nomenclature will be used in a few cases where it is desired to emphasize the supposed electron positions.

The normal structure of hexaphenylethane is accordingly the following:

A.



(All the phenyl groups have the same structure as those given in detail.)

The three strongly negative phenyl groups attached to carbon atom (*1*) draw six of its shell electrons away from the kernel. Consequently the remaining two electrons, namely those shared by carbon atoms (*1*) and (*2*), are held very firmly by the kernel of (*1*). Similarly these two electrons are held very firmly by the kernel of carbon atom (*2*). It therefore follows from the Lewis-Langmuir theory of valence that hexaphenylethane cannot possibly dissociate without a rearrangement of one or more of the phenyl groups. This conclusion is thoroughly substantiated by the experimental evidence that dissociation of this and similar compounds does not occur without color. The chromophoric nature of the quinoid form of the benzene ring has long been established. The reason for the formation of a quinoid ring is generally that electrons are pulled toward two atoms connected to para or ortho carbon atoms. In the case under discussion it is evident that the strong pull of electrons toward one atom attached to each ring [carbon atoms (*1*) and (*2*)] is sufficient under certain conditions to cause rearrangement and consequent dissociation.

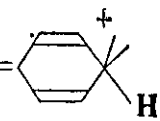
In nonionizing solvents such as benzene, rearrangement and dissociation occur symmetrically. One electron between C (*3*) and C (*4*) is pulled to a position between C (*2*) and C (*3*), resulting in a quinoid ring in which C (*6*) lacks one electron. The electrons shared between C (*1*) and C (*2*) are now no longer held firmly by C (*2*), which momentarily has nine electrons in its shell. Therefore C (*1*) and C (*2*) separate symmetrically, each retaining one electron of the shared pair. A double bond

of four electrons is immediately established between C (*2*) and C (*3*). The structure of the resulting nonionic dissociation product is shown in formula B, which is identical with the quinoid modification in Gomberg's formula II.

B. $(C_6H_5)_2=C=$

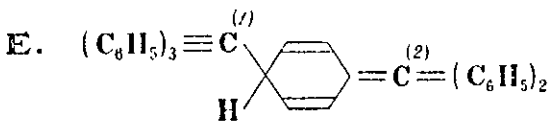
When carbon atoms (*1*) and (*2*) separate it is not to be supposed that C (*1*) continues to exist with only seven electrons in its shell, six of which are drawn away from the kernel by the chemically negative phenyl groups. The eighth electron is undoubtedly supplied by a quinoid rearrangement in the left-hand part of the molecule (formula A) identical with the one described for the right-hand part and taking place practically at the same time as the dissociation or before it. That is, the dissociation of hexaphenylethane in nonionizing solvents is symmetrical, giving two neutral molecules which cannot strictly be called triphenylmethyl and which have the structure shown in formula B.

When hexaphenylethane is dissolved in a solvent, such as sulphur dioxide, which contains unshared electrons (that is, an ionizing solvent) the dissociation occurs unsymmetrically. This is caused by an unstable union with a solvent molecule which supplies two additional electrons to the shell of carbon atom (*6*). A quinoid rearrangement takes place as before described except that *two* electrons are supplied by the ring to the union between C (*2*) and C (*3*). Carbon atom (*2*) now has momentarily ten electrons, so that C (*1*) separates, carrying with it *both* of the shared electrons. The left-hand part of the molecule (formula A) thus forms a colorless negative ion (C) and the right hand part forms a colored positive ion (D). The formula below shows only the ion proper without the solvent molecule, which undoubtedly remains loosely attached to the para carbon atom, which otherwise would have two vacancies in the shell.

C. $(C_6H_5)_3\equiv C^-$ **D.** $(C_6H_5)_2=C=$ 

Since C (*1*) has completed its octet and hence has a negative charge while C (*6*) has lost two electrons and therefore has a positive charge, it is quite conceivable that the two ions can

reunite in such a manner that C (*6*) is attached to C (*1*), forming the compound:



Two neutral molecules of B can probably also unite and rearrange to give E.

The above explanation leads us to the conclusion that hexaphenylethane can exist in the modifications A, B, C, D, and E. This is essentially the same conclusion that Gomberg arrived at, except that colorless triphenylmethyl can exist, according to the present theory, only in the form of a negative ion, and that, in the positive ion, one of the para carbon atoms has two unsatisfied affinity units. As for trivalent carbon, the form B contains a para carbon atom in a truly trivalent condition, namely, with one unsatisfied affinity unit. The positive ion exists only in combination with a solvent molecule. The negative ion contains a carbon atom (the central atom) in the satisfied but tricovalent condition which is found in many organo-metallic compounds, and is particularly stable when three pairs of electrons are strongly drawn away from a carbon kernel (as in the case of metallic acetylene derivatives).

Having explained the existence of the various types of hexaphenylethane let us examine their chemical and physical properties in the light of the octet theory.

PHYSICAL PROPERTIES

Color.—Hexaphenylethane is colorless in the solid state; it has colored and colorless modifications in solution. We would expect the compound B, the positive ion D and the compound E to be colored, owing to the presence of the quinoid group. On the other hand, the negative ion C and hexaphenylethane A should be colorless. It should be possible to demonstrate experimentally that the positive ion is the colored ion and the negative ion colorless by electrolysis of a solution of hexaphenylethane in a dissociating solvent.

Piccard [18] by applying Beer's colored solution law shows that a solution of hexaphenylethane in ether undergoes dissociation from R_6C_2 to R_3C as dilution increases. If the solution is caused to crystallize, only the polymer R_6C_2 is deposited be-

[18] Piccard, J., Ann. d. Chem. 381 (1911) 347.

cause the equilibrium is disturbed. Schmidlin [19] states that the equilibrium between the colored and the colorless modifications is affected by the nature of the solvent, temperature, etc. At −63° C. in ether solution there is no color.

Conductivity.—Hexaphenylethane dissolved in liquid sulphur dioxide behaves like an electrolyte. It conducts the electric current, and its molecular conductivity increases with dilution of the solution.[20] This is exactly what we would expect of the positive and negative ions of hexaphenylethane.

CHEMICAL PROPERTIES

Oxidation.—Gomberg lays great stress on the remarkable avidity with which "triphenylmethyl" takes up oxygen to form a peroxide. This is one of the main reasons why the dimolecular form (hexaphenylethane) is not regarded favorably, for one is led to look, rather, for an unsaturated compound. But let us examine the interatomic conditions in the molecule of hexaphenylethane. We have, it is true, a strong union between carbon atoms C(*1*) and C(*2*) (compound A, page 685), due to the strong elastic constraints of the six negative phenyl groups. But these six negative groups tend to pull the electrons away from the nuclei of carbon atoms C(*1*) and C(*2*), leaving large open spaces which become strong positive poles. Under these conditions an oxygen molecule is attracted and enters one of the large open spaces in the shell, say, of carbon atom C(*2*). This atom then has, momentarily, two more than its normal number of electrons.[21] The carbon atom C(*1*) still has a strong attraction for the pair shared between itself and carbon atom C(*2*), but this pair is no longer held firmly by C(*2*), so that the bond is broken and two ions are formed:

$$(C_6H_5)_3 \equiv C^- \text{ and } \overset{\delta}{O}=O \; C^+ \equiv (C_6H_5)_3$$

Due to the attraction of the positive carbon kernel, C(*2*), all of the electrons in the oxygen molecule shift toward the carbon, leaving a positive area on the outer oxygen atom, which then joins to the negative ion, forming the peroxide molecule:

$$(C_6H_5)_3 \equiv C-O-O-C \equiv (C_6H_5)_3.$$

[19] Loc. cit.

[20] Walden, Zeitschr. phys. f. Chem. 43 (1903) 443; Gomberg and Cone, Ber. deutsch. chem. Ges. 37 (1904) 2043.

[21] Perkins, G. A., loc. cit.

Here we have, then, a satisfactory explanation of the oxidation of hexaphenylethane without the supposition of the compound existing in the form of the radicle triphenylmethyl. That is, the reaction is to a large extent of the direct-addition rather than the dissociation-addition type.

The oxidation of the colored compound E proceeds in a somewhat analogous manner, the chemically negative oxygen molecule attaching itself to either carbon atom C(*1*) or C(*2*); the break occurs and the peroxide is formed.

Similarly oxygen adds to the central carbon of compound B. The product contains an uneven number of electrons, which probably causes a three-electron bond to be formed between the oxygen atoms. In this case the shift of electrons in the oxygen molecule is toward the outer atom, which thus becomes very active in attacking the positive open spaces in the shell of the central carbon atom of another molecule of B, thus forming the same peroxide as above-mentioned.

Addition of hydrogen.—Molecular hydrogen does not react with hexaphenylethane. Zinc dust and acetic acid, however, cause the addition of hydrogen, which probably occurs as follows: Zinc like any positive metal furnishes free electrons, which cause the formation of negative ions (formula C) at its surface. These negative ions rapidly combine with hydrogen ions furnished by the acid, and triphenylmethane is formed.

Addition of halogen.—Chlorine and bromine form both substitution and addition products; iodine forms only addition products with hexaphenylethane. The halogen molecule contains a number of unshared electrons, one or more of which during a thermal impact enter an exposed positive space in the distorted shell of the central carbon atom in compound B. By rearrangement to the benzoid form one of these electrons is accommodated in the shell. Any others that may enter are repulsed and one unshared electron in the carbon atom shell joins the newly arrived halogen electron to form a shared pair between the carbon and halogen atoms. The excess of one electron causes the outer halogen atom to dissociate as a neutral atom, which is very active in substituting or adding to a second molecule of compound B.

Addition of xylene.—Wieland and Müller[22] found that, on boiling hexaphenylethane with *o*- or *p*-xylene, dimethyltetraphenylmethane is formed:

$$(C_6H_5)_6C_2 + C_6H_4(CH_3)_2 = (C_6H_5)_3C.C_6H_3(CH_3)_2 + (C_6H_5)_3CH.$$

[22] Wieland, H. u. Müller, C., Ann. d. Chem. 401 (1913) 238.

The reactivity in this case is much less than in the cases previously described, necessitating as it does a high temperature. The heat may activate the xylene as well as the hexaphenylethane, so that the problem of the reaction mechanism is more complicated. The general course of the reaction is analogous to the substitution of chlorine in the xylene ring.

SUMMARY

(1) An explanation of the constitution of hexaphenylethane based on the octet theory of valence has been proposed.

(2) The physical and chemical properties of hexaphenylethane have been shown to be more satisfactorily explained by this theory than by the old affinity unit theory of valence.

NEW OR NOTEWORTHY PHILIPPINE BIRDS, IV

By RICHARD C. MCGREGOR

Ornithologist, Bureau of Science, Manila

FOUR PLATES AND THREE TEXT FIGURES

This paper consists of notes on several species of Philippine birds that are rare or otherwise of unusual interest. The genus *Erythrura* is added to the Philippine list, but unfortunately the species cannot be determined at present. *Chætura picina* was collected in two islands in 1920, although nothing had been seen of it for fifteen years. These captures confirm the long-held opinion that much more ornithological field work is necessary in the Philippine Islands. Only a few of the smaller islands have been thoroughly explored for birds, and the work on the larger islands has been far from complete. From no locality or island have we a record of observations made throughout an entire year. Merrill [1] has shown how incomplete and fragmentary botanical exploration has been, and zoölogical exploration has been equally inadequate.

Megapodius cumingi Dillwyn.

On August 1, 1921, Mr. L. H. Taft brought to the Bureau of Science a chick and two eggs of the tabon. Efforts were made to rear the young bird, but it died in a few days. These specimens were secured near Calabgan, Casiguran, Tayabas Province, Luzon, through the interest of Capt. M. G. Martling. The matter is worthy of notice, because the tabon has been rarely recorded from Luzon. However, Captain Martling says that tabons are common near Casiguran.

Francolinus pintadeanus (Scopoli). Plate 1, fig. 1; text fig. 1.

Tetrao pintadeanus SCOPOLI, Del. Flor. et Faun. pt. 2 (1786) 93.

Francolinus chinensis GRANT, Cat. Bds. Brit. Mus. 22 (1893) 136 (*Tetrao chinensis* Osbeck, 1771, not of Linnæus, 1766); OATES, Hume's Nests and Eggs of Indian Bds. 3 (1890) 431; Cat. Bds.' Eggs Brit. Mus. 1 (1901) 37, pl. 2, fig. 4.

A pair of francolins was collected by Macario Ligaya, on July 4, 1919, near Balagbag, Rizal Province, Luzon. These speci-

[1] Philip. Journ. Sci. § C 10 (1915) 159–167.

mens are now in the Bureau of Science collection, Nos. 13326 and 13327. The male was only slightly wounded, and a photograph shows the bird in a somewhat unnatural attitude. Other individuals of this species were seen in the same locality. There is also a mounted specimen in the zoölogical laboratory of the College of Liberal Arts, which was collected near Fort William McKinley.

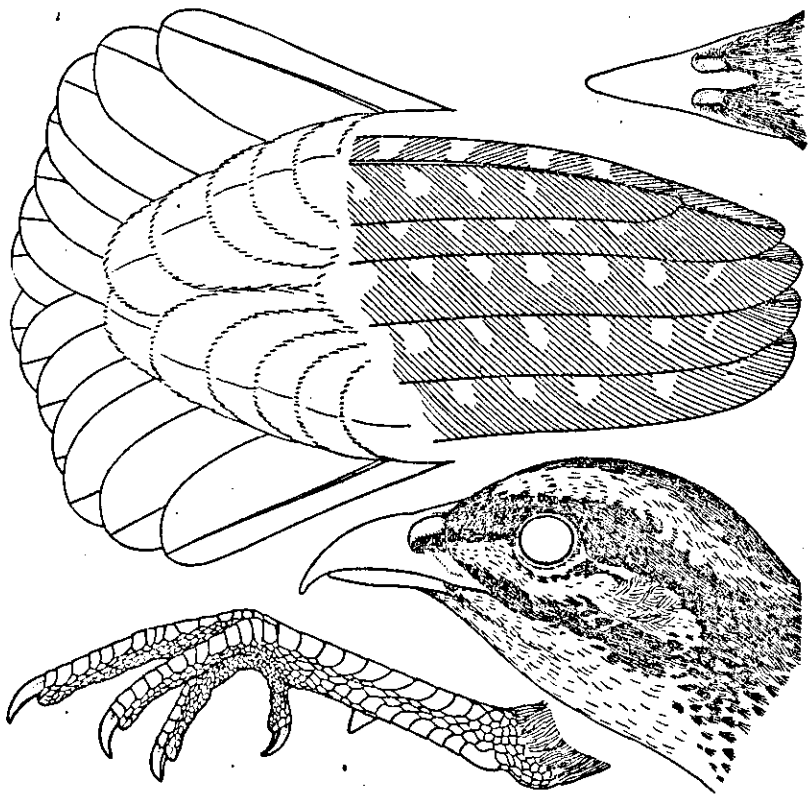


FIG. 1. *Francolinus pintadeanus* (Scopoli); generic details, × 1.

On June 6, 1921, a nest containing five slightly incubated eggs was found near Balagbag. The parent birds were collected with this set. The eggs measure in millimeters: 36.7 by 31.3, 38.4 by 30.7, 37.5 by 30.5, 37.7 by 31.0, 36.6 by 30.0. Three days later another nest, containing three slightly incubated eggs, was found in the same locality. These eggs measure in millimeters: 38.0 by 31.3, 39.6 by 31.1, 39.0 by 30.7. A few days later a third nest was found. The nest in each case was on the ground in a thick bunch of grass about a meter high.

The eggs are the color of good coffee that has plenty of cream in it, somewhat near Ridgway's cinnamon-buff. The shell is compact and somewhat glossy. Under a lens small scattered pits are revealed. Oates says that some of the eggs of the common francolin "exhibit white spots, as if the outer layer of the shell had become disintegrated," but he does not mention white spots in connection with the eggs of the Chinese species. Each of the eight eggs from Balagbag has very evident white markings. These are most numerous near the larger end in each egg. Most of them are very small dots, but a few are spots measuring from 1 to 2 millimeters in diameter. Under the lens these white spots appear to be surface markings and not the result of the disintegration of part of the brown layer. When the eggshell is held toward the light, the opposite side appears light green through the blowhole. The shape of the egg is well represented in the Catalogue of Birds' Eggs, but the coloring of the figure is not very near that of the few eggs I have seen.

I assume that some of these birds had been recently liberated near Manila. I have met a man who told me that he had released five hundred or more in the vicinity of Balagbag. If this species will thrive here, it will probably be a valuable addition to the Philippine fauna, which is very poorly supplied with upland game birds. The following description will serve for the identification of specimens:

Male.—General color dark brown, with many conspicuous white spots; top of head blackish brown, on each side of this a tan stripe from base of bill to occiput, a black stripe from bill through eye to neck, below eye a white stripe from bill to ear, below this a black line; neck and mantle black, each feather with four or six white spots; back, rump, and tail coverts black, barred with narrow wavy white lines; chin and upper throat white, lower throat black, spotted with white similar to mantle but more white, the white spots increase in size on breast and abdomen until the black is reduced to bars; under tail coverts rusty buff, wings dark brown with bold spots of cinnamon-buff; flanks and thighs washed with cinnamon-buff. Bill black; iris dark brown; legs and feet ochraceous orange; nails horn gray. Wing, 147 millimeters; tail, 85; tarsus, 40; middle toe with claw, 37; culmen from base, 28; bill from nostril, 17.

Female.—General color and pattern similar to those of the male, but stripes on side of head obscure. Wing, 139 milli-

meters; tail, 84; tarsus, 37; middle toe with claw, 34; culmen from base, 24; bill from nostril, 14.5.

The distribution of the Chinese francolin is given as Indo-Chinese countries, Burma, Siam, Cochin China, Hainan, and southern China; it is said to have been introduced in Reunion and Mauritius.

I am indebted to Dr. C. W. Richmond and Mr. J. H. Riley, of the United States National Museum, who kindly identified the specimens and furnished notes on the nomenclature. Osbeck's name for this species is preoccupied by the same combination, which was used by Linnæus to designate what is now called *Excalfactoria chinensis*. Scopoli's name seems to be the next one.

Excalfactoria lineata (Scopoli).

On June 23, 1921, Macario Ligaya gave me a pair of island painted quails that had been snared near Balagbag, Luzon. I took them home, put them in a box, and furnished them with water and such grain as I could find. They were very wild, jumping about and dashing against the cage. One of them called "tic-tico" during the afternoon and again at dusk. The male died during the night. On June 25 I sat near the cage reading most of the afternoon. The female called three times at long intervals. That night I heard her twice at about 1 o'clock. This call had a rich, plaintive quality. There was nothing of the bright happy quality characteristic of the call of the bobwhite or the California valley partridge. On July 2, after 9 o'clock in the evening, the female called three times at half-hour intervals. Each call consisted of four notes.

On July 3 Ligaya and I went to Balagbag, where the station agent gave us another pair of painted quails and a rail, *Hypotænidia striata* (Linnæus). He also gave us an egg that the quail had deposited during the night. The egg measures 24 by 19.4 millimeters; its color is nearly uniform grayish olive. The shell is compact and without pits, but has numerous, minute, dark brown dots, which are clearly raised above the surface. At the larger end a few of these dots can be distinguished without the aid of a lens. One of them is 0.5 millimeter in diameter. Through the blowhole the shell appears dark green.

Sterna hirundo Linnæus.

Mr. W. Cameron Forbes, while visiting Bohol Island, on July 10, 1921, collected a female of the common tern. The specimen

is much like the one collected in Calayan Island,[2] but the nape is blacker and is followed by a white space on the neck, while the mantle and upper wing coverts are pearl gray. The bill, the feet, and the claws are black in the dry specimen.

Anous stolidus (Linnæus).

The noddy tern is to be added to the birds known from Luzon on the basis of a male collected in Manila Bay, on May 5, 1908, by B. Barbaza, a local taxidermist. The specimen is in pale brown plumage with slight indications of the gray cap. This record is published through the courtesy of Mr. W. Parsons, who purchased the specimen from the collector.

Canutus tenuirostris (Horsfield).

Among several hundred bird skins obtained by Mr. W. Cameron Forbes, during his visit to the Philippine Islands in 1921, was a male knot collected in Sitanki on August 22. Sitanki is a small island near Sibutu, in the most southern part of the Archipelago.

Lophotriorchis kieneri (Geoffroy St. Hilaire).

A hawk collected near Badajoz, Tablas Island, on September 23, 1905, was recorded by me as *Lophotriorchis kieneri* with an interrogation.[3] I have thought it worth while to send the specimen to the United States National Museum for further examination. Mr. J. H. Riley confirms my determination of it as representing an immature plumage of the above species. The specimen is No. 11220, male, Bureau of Science collection.

Spizaëtus limnæëtus (Horsfield). Plates 2 and 3.

While Col. John R. White was in charge of the penal colony in Palawan he secured a living specimen of a large hawk which he sent to the Bureau of Science. The bird was received on June 17, 1908, in good condition. Through the patience and skill of Mr. Charles Martin, then photographer in the Bureau of Science, several good negatives showing the bird in various positions were secured. Prints from two of these are reproduced. I had considered this bird a specimen of *Lophotriorchis*, but Mr. J. H. Riley has identified it as *Spizaëtus limnæëtus*. I think no previous record of this specimen has been made, so no harm is

[2] Philip. Journ. Sci. § D 13 (1918) 3.
[3] Philip. Journ. Sci. 1 (1906) 772.

done by my error. The specimen is No. 13331, immature male, Bureau of Science collection.

Description.—Head and neck about maize yellow; mantle blackish brown, the feathers edged more or less with pale buff; back and rump light brown, upper tail coverts light brown, nearly white; lower parts white, a patch on the flanks light pinkish cinnamon; faint indications of brown bars on upper thighs; wings blackish brown; median coverts largely white, forming a broad band; tips of secondaries and tertials white, inner webs of primaries white basad of cut in inner web; rectrices with alternating light and dark brown bars, the dark bars about half as wide as the light ones, the latter mottled with white, seven dark bars including the subterminal one, which is scarcely distinguishable from the preceding wide dark brown band; tip of tail white, on the underside the light bars nearly white and the dark bars less distinct than above. Iris brown; bill and nails black; feet light yellow. Length, 650 millimeters; wing, 410; tail, 29; culmen from base, 39; culmen from cere, 31; tarsus, 94; middle toe with claw, about 85.

Pithecophaga jefferyi Grant. Text fig. 2.

The monkey-eating eagle from Imugan, Nueva Vizcaya Province, Luzon, already recorded by me died in the Manila botanic garden early in 1918. The skin is now in the Bureau of Science collection, No. 7748, female. Most of the skeleton, together with the head and a foot of the specimen collected by Mr. H. M. Ickis in Laguna Province, Luzon, was sent to Dr. R. W. Shufeldt for study and is the material used in the description of the osteology of the species.[4]

Since publishing my last notes[5] on the monkey-eating eagle I have handled two more specimens, have seen another mounted, and have heard of two others that I did not see.

1. An eagle of this species, the source of which is unknown, lived for some months in the Manila botanic garden. It died in November, 1918, and was sent to the Bureau of Science. The skin is in the Bureau of Science collection.

2. Mr. Pedro Pulgado, of Manila, while working at Kolambugan, Mindanao, secured a living monkey-eating eagle, which

[4] Philip. Journ. Sci. 15 (1919) 31–58, pls. 1–11.
[5] Ibid. § D 13 (1918) 14.

he brought to Manila where it lived for some months and became fairly tame. It was fed on meat and fish. The bird was sick for two or three weeks before it died, in January, 1920. The owner brought it to the Bureau of Science for mounting. The body was found to be heavily infested with peculiar nodules whose nature has not been ascertained. Some trematodes taken from the intestines and preserved by Prof. Frank G. Haughwout, of the Bureau of Science, have been described as *Phagicola pithecophagicola*, a new genus and new species.[6] Faust considers this new worm so distinct that he erects a new subfamily, Phagicolinæ, for the genus.

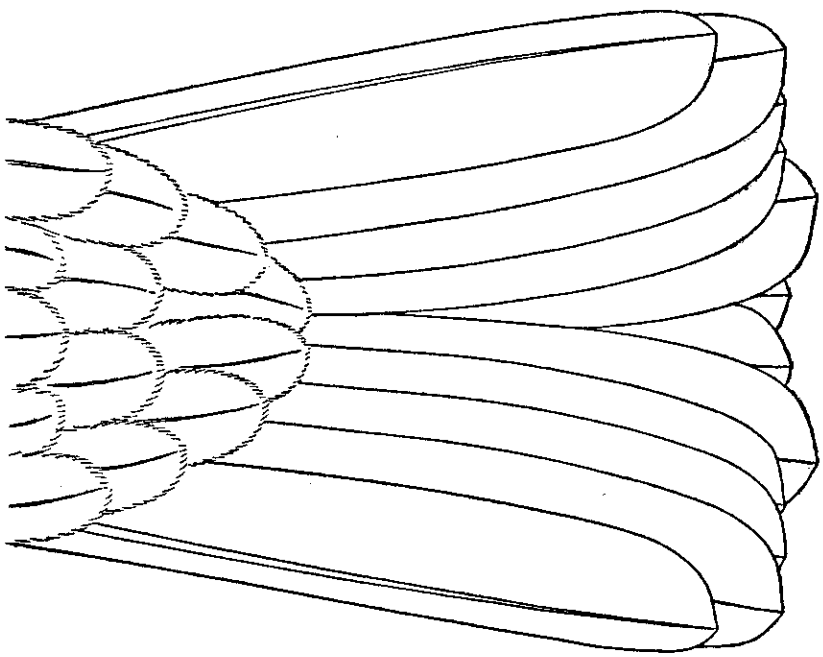


FIG. 2. *Pithecophaga jefferyi* Grant; outline of the tail, × 0.25.

The following data were taken from this specimen: Iris pale blue; cere and face deep plumbeous, base of bill grayer, most of bill blackish slate; tarsus and toes dirty barium yellow; weight, 2.76 kilograms. Fourth, fifth, and sixth primaries nearly equal and longest; first primary 75 millimeters shorter than second; second shorter than third and about equal to seventh.

[6] Faust, E. C., Philip. Journ. Sci. 17 (1920) 627–633, pl. 1.

Measurements of the Kolambugan eagle.

	mm.
Length	960
Extent	1,910
Wing, flat on rule	595
Tail	440
Tarsus	125
Inner toe with claw	98
Middle toe with claw	112
Outer toe with claw	85
Hind toe with claw	84
Depth of bill at nostril	48
Width of bill at cutting edge	19
Chord of culmen from cere	68
Height of nostril opening	12

3. Several individuals reported to me that they noticed a live specimen of the Philippine eagle in one of the exhibits from the Southern Islands at the 1920 Philippine Carnival. Unfortunately, the fire that destroyed nearly all of the exhibits occurred before I visited the Carnival, and I did not see this specimen. However, the eagle is so distinctive that it is unlikely that any other bird could have been mistaken for it.

4. In one of the stores on the Escolta, Manila, I have noticed a mounted specimen of this eagle in 1920. I have no information as to where it came from.

5. Mr. O. W. Pflueger, forester of the Bureau of Forestry and stationed at the Forest School, Los Baños, informs me that he has seen a foot of an eagle which was killed on Mount Maquiling. Although he tried to purchase the specimen, he could not do so. The bird was killed on September 22, 1920, and was destroyed before Mr. Pflueger was able to secure any part of it. The following interesting memorandum was furnished by Ranger Carlos Sulit:

> On September 22, 1920, about 7 a. m. Pedro Gibas, a logger and resident of Barrio Anos, Los Baños, Laguna, was riding a carabao on the Tanza trail on Mount Maquiling as he was on his way up the mountain to skid logs. On this trail he met a big bird the like of which he had never seen before. The carabao refused to proceed and so he dismounted in order to procure a pole and capture the bird. However, he did not have time to procure one as the bird followed and attacked him. He drew his bolo and struck it on the wing. This angered the bird and it attacked him again. He then hit it on the head and killed it.
>
> According to Gibas the bird when standing was about 1 meter high and the wings when spread measured about 1.5 meters. The tail of the bird was bought by a student of the College of Agriculture and the meat was eaten by the Gibas family and what was left was given to the dogs.

A cochero by the name of Mamerto Peralta, living in the coconut grove near the College of Agriculture, bought one of the claws which he refused to sell.

No one seems to know the common name of this bird, and they simply call it an eagle. A student of the College of Agriculture who saw this claw says it must be the same species of bird as that which attacked and killed a Negrito in Zambales while protecting her young one. The young of this bird is at present in the possession of a man in San Marcelino, Zambales, who has it for exhibition purposes.

I offer the foregoing account without excessive confidence in either the identity of the species or the accuracy of the statements concerning the struggle of the man with the bird. This species may be expected to occur in the forests near Mount Maquiling as it was definitely recorded by me from the mountains east of Mount Maquiling some years ago, the record being based upon the head, a foot, and a wing of the specimen killed by Mr. Harry M. Ickis. The head and foot of the Ickis specimen are the ones used by Shufeldt in his monograph on the osteology of this eagle.

Baza magnirostris Gray.

The large-billed baza is one of the rare endemic Philippine hawks. The only specimen that I have seen was collected by Andres Celestino on Agusan River, in northern Mindanao, on December 17, 1909.[7] The specimen is a female, No. 12940 of the Bureau of Science collection. Mr. J. H. Riley has confirmed my identification.

Pseudoptynx philippensis Kaup. Plate 1, figs. 2 and 3.

On May 2, 1921, we received a live owl at the Bureau of Science. Under the date April 30 Mr. Dean C. Worcester, of Cebu, wrote that he had received this owl from Catbalogan, Samar. The bird appears to be *Pseudoptynx philippensis*, but in its present condition is rather too lively for a close comparison with our museum specimen from Benguet Province. This bird eats rats, guinea pigs, and beef with gusto, and appears to be perfectly healthy. It was still living in December, 1921. No species of this genus has been recorded from either Samar or Leyte.

Chætura picina Tweeddale. Text fig. 3.

Chætura picina TWEEDDALE, Proc. Zool. Soc. London (1878) 944, pl. 59; GRANT, Ibis VII 3 (1897) 242.
Mearnsia picina RIDGWAY, Bull. U. S. Nat. Mus. 50[6] (1911) 686.

[7] Philip. Journ. Sci. § D 5 (1910) 197.

Chætura picina was described by Tweeddale from a female specimen collected by Everett near Zamboanga, Mindanao, in April, 1878. The next specimens known are two males and a female that were secured by Whitehead in Leyte in 1896. About 1904 Mearns collected one or more specimens of this species in Mindanao. Since then this swift has not been seen, so far as known, until 1920. Mr. E. H. Taylor recently returned from Mindanao and brought a few birds that he collected in the vicinity of Zamboanga. Among these was one specimen of *Chætura picina* collected on September 25, 1920, which Mr. Taylor very generously presented to the Bureau of Science. Andres Celestino, who was collecting in Cebu during December, secured a female of this species at Toledo, Cebu, on December 21, 1920. It is curious that this species had not been seen for years and that these two specimens were collected within three months of each other.

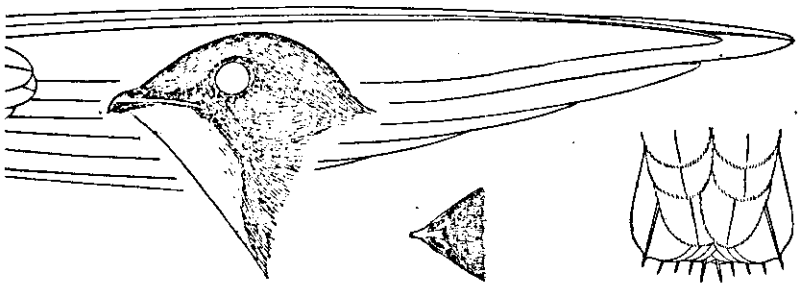


FIG. 3. *Chætura picina* Tweeddale; generic details, × 1.

Ridgway has erected the genus *Mearnsia* for the reception of this species. In the two specimens of *Chætura picina* at hand the first primary is decidedly shorter than the second and longer than the third. The tail is relatively shorter than in *Chætura gigantea*, and the spines of the rectrices are also comparatively short.

Tachornis pallidior McGregor.

Mr. W. Parsons collected a pair of paler palm swifts at Pagsanjan, Laguna Province, Luzon, on January 6, 1921. I have collected this species near Manila and in Tarlac Province, Luzon.

Hirundo striolata (Boie).

On June 18, 1921, Prof. S. F. Light and I noticed from ten to twenty pairs of mosque swallows flying about the quarantine dock at Mariveles, Bataan Province, Luzon. Some nests were

plastered to the underside of the cement dock, but we could make no further observations as we were just leaving for Manila. I believe this is the first observation of the nesting of this species in Luzon.

Zanthopygia narcissina (Temminck).

My Philippine record of the narcissus flycatcher was based upon a female specimen from Calayan Island. This was not included in my report on the Calayan collection,[8] but was noted later.[9] As there appear to be only two Philippine records for this species, I thought it worth while to have my determination verified. The specimen, No. 3766, Bureau of Science collection, was accordingly sent to the United States National Museum where Mr. J. H. Riley confirmed my identification.

Malindangia mcgregori Mearns. Plate 4.

The plate of this species published herewith is from a male topotype in the Bureau of Science collection, No. 12907. The only specimens known are those collected by Mearns on Mount Malindang, Mindanao, in 1906.

Turdus chrysolaus Temminck.

Mr. W. Parsons has a male of the Japanese brown thrush that was collected by B. Barbaza at Balintauac, near Manila, on January 16, 1909. Whitehead found a few specimens of this thrush "on the summit of Monte Data [in northern Luzon] mingling with the flocks of *T. obscurus*" in November and December. I found the species fairly abundant in Calayan late in November and during December. I suspect that thorough field work in northwestern Luzon during October, November, and December would yield a lot of interesting information concerning migratory land birds.

Amandava amandava (Linnæus).

Sporæginthus amandava (Linnæus), McGregor, Philip. Journ. Sci. § D 11 (1916) 275. [*Amandava* Blyth, Richmond, Proc. U. S. Nat. Mus. 35 (1908) 588.]

On March 18, 1921, I noticed about fifty small birds in a Manila store. These were of the species reported by me from Manila as *Sporæginthus amandava*. All of them were immature, with gray or clay-colored underparts. A few were in mottled

[8] Bull. Philip. Mus. 4 (1904).
[9] Man. Philip. Birds (1909) 449.

plumage, recalling the corresponding plumage of *Munia jagori*. Later the same day, while crossing Puente Colgante, I met an old man with two bamboo cages containing a hundred or more of these birds, all in young plumage. This man told me that he caught these birds near San Vicente, Ilocos Sur Province, and that they change to the adult plumage in May. On May 9 I again saw this man with a lot of these birds. He was telling a crowd how the birds changed plumage and that they nested in thick grass on the ground. Perhaps he meant to say near the ground. As he was talking to a crowd of Filipinos and not to me, I am inclined to the view that he really gets the young birds from the nests. If he was telling the truth, the species is evidently well established in Luzon, and this is the point that I was interested in.

Erythrura species.

Mr. L. H. Taft, of the Bureau of Forestry, who is stationed at Los Baños, Laguna Province, Luzon, sent four specimens of a green-backed ricebird to Mr. E. H. Taylor and under date of July 7, 1920, wrote:

> The four birds that you received last week were in very bad condition when I found them. A week ago Saturday we started to string a wire for the backstop on our tennis court at the school. We failed to finish, but left the wire standing up. The next Saturday (June 26) we started to finish the job and found that ten of these same birds had evidently flown against the wire and suffered an untimely death during the week. Six of them were too far gone to send at all (the ants had eaten out their throats) but the four I sent in seemed to be O.K. It doesn't seem probable that we caught a flock migrating for eight were on one side of the wire and two were on the other side. Only one of the men seemed to know the bird. He said he had seen many of them in San Carlos, Pangasinan.

These specimens were unfortunately so badly decayed that they could not be skinned, and one was dropped into alcohol. In attempting to identify this specimen I felt fairly safe in the genus *Erythrura* and thought that the species might be *E. trichroa*.[10]

On August 20, 1920, the specimen was sent to the United States National Museum where Dr. C. W. Richmond with characterestic care examined it. As the matter is rather important, I quote Doctor Richmond's comment in full. He said:

> The specimen is in poor condition for determination, and is probaby a female or immature bird, which makes a satisfactory identification more

[10] Sharpe, Cat. Bds. Brit. Mus. 13 (1890) 385.

difficult. It belongs to the genus *Erythrura*, but it has a smaller bill than *E. trichroa*, though the colors agree fairly well with the description of the young of the latter, except for the color of the bill. As the bill is wholly black in the Philippine bird, the specimen is more likely to be an adult than an immature one. In dimensions and size of bill, the specimen is close to an adult of *E. tricolor* from Wetter Island, but it differs greatly in color and is manifestly out of place there. It probably represents a new form, but adult males will be necessary to settle the matter.

This discovery is extremely interesting. If the species of this genus were migratory and if one specimen had been found, it would not be very surprising; however, so far as I can make out the known species are resident in rather restricted areas. The probability is that we are dealing with an unknown resident species. Ten individuals of this species being killed in one day suggests that collectors must do more field work before the species of Philippine birds are all recorded.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Francolinus pintadeanus* (Scopoli); a living bird from Balagbag, Luzon. Photograph by E. Cortes.

2. *Pseudoptynx philippensis* Kaup; a living bird from Samar. Photograph by E. Cortes.

3. *Pseudoptynx philippensis* Kaup; showing nictitating membrane of left eye closed. Photograph by E. Cortes.

PLATE 2

Spizaëtus limnæëtus (Horsfield); immature male, from Palawan. Photograph of the living specimen by Charles Martin.

PLATE 3

Spizaëtus limnæëtus (Horsfield); another view of the specimen shown in Plate 2.

PLATE 4

Malindangia mcgregori Mearns; from a male topotype, Bureau of Science collection, No. 12907. Drawn and colored by Macario Ligaya. Reduced about one-fourth.

TEXT FIGURES

FIG. 1. *Francolinus pintadeanus* (Scopoli); generic details, × 1.

2. *Pithecophaga jefferyi* Grant; outline of the tail, × 0.25.

3. *Chætura picina* Tweeddale; generic details, × 1.

Drawings for the three text figures were made by Macario Ligaya.

Fig. 1.

Fig. 2.

Fig. 3.

PLATE 1.

PLATE 2. SPIZAËTUS LIMNÆËTUS (HORSFIELD).

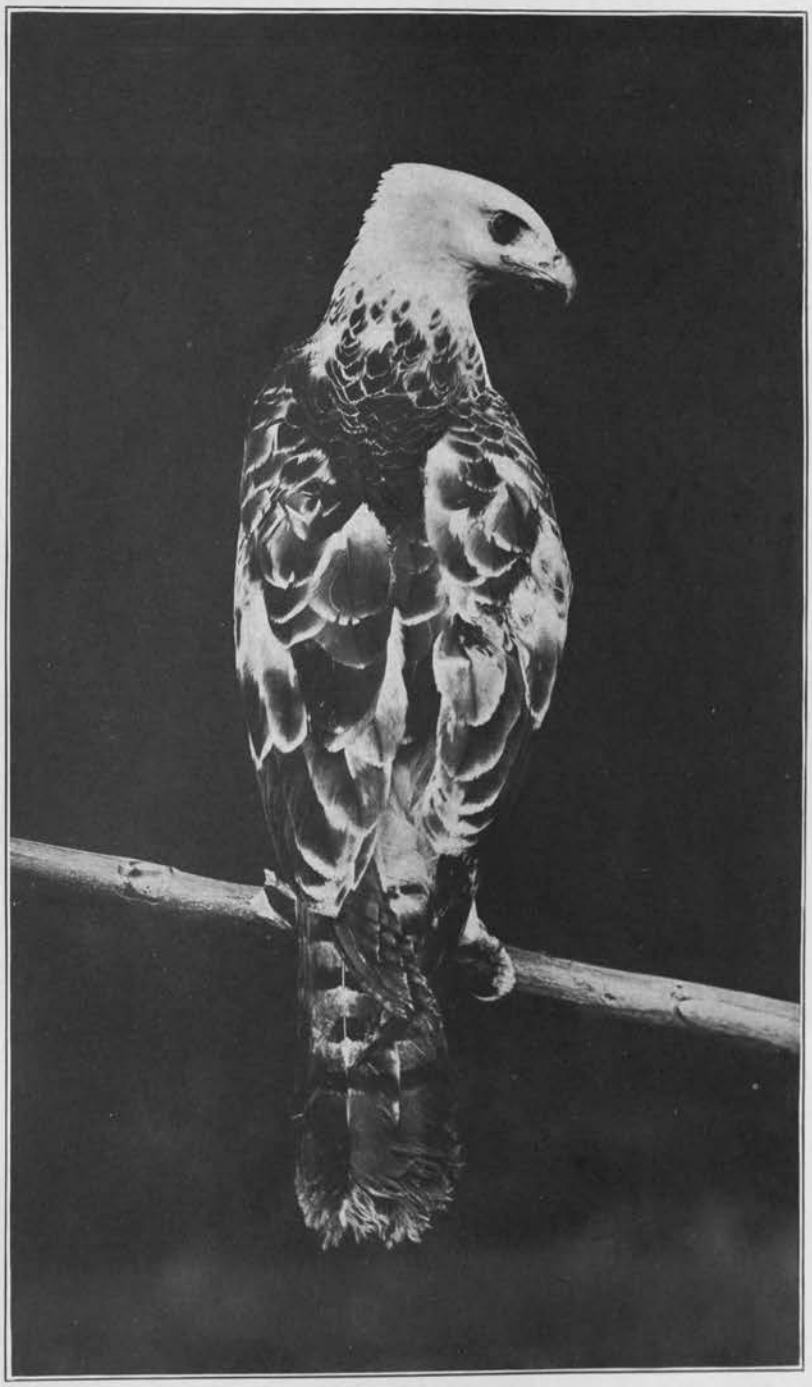


PLATE 3. SPIZAËTUS LIMNÆETUS (HORSFIELD).

PLATE 4. MALINDANGIA MCGREGORI MEARNS.

DIE VIOLEN DER PHILIPPINEN

Von WILHELM BECKER
Rosian (Magdeburg)

In dem letzten Jahrzehnt beschäftigten mich besonders die Violen Asiens und Australiens. Die Ergebnisse meiner intensiven Studien sind zu einem Teile bereits der Oeffentlichkeit übergeben.[1]

Auch das Bureau of Science, Manila, übersandte mir das in seinem Herbar befindliche asiatische Violenmaterial, wofür ich der Direktion auch an dieser Stelle meinen Dank ausspreche. Auf Wunsch veröffentliche ich nun eine Bearbeitung der Violen der Philippinen. Das dieser Arbeit zu Grunde liegende Pflanzenmaterial, etwa 55 Bogen, befindet sich fast ausschliesslich im Herbarium des Bureau of Science, Manila.

Auf den Philippinen sind bisher neun Violaspezies festgestellt: *V. arcuata* Blume, *V. semilunaris* W. Bckr. var. *philippinarum* W. Bckr., *V. merilliana* W. Bckr., *V. diffusa* Ging. und ihre subsp. *tenuis* W. Bckr., *V. rupicola* Elmer, *V. mearnsii* Merr. *V. ramosiana* W. Bckr., *V. betonicifolia* Sm. subsp. *nepalensis* W. Bckr., *V. inconspicua* Blume, und *V. philippica* Cav. subsp. *malesica* W. Bckr. Die Areale dieser Arten liegen in der Hauptsache auf den Inseln Luzon and Mindanao; sonst kommen noch die Inseln Mindoro und Negros mit je einer Spezies in Betracht, die aber auch auf den beiden grossen Inseln vorkommen. Auf der Insel Luzon und zwar im nördlichen Teile, ungefähr im Gebiet der Provincia Mountain, treten sämtliche zehn Arten auf, die *V. betonicifolia* und *inconspicua* ausserdem auch in der Provincia Cagayan, die *V. mearnsii* auch in der Provincia Laguna. Auf Mindanao kommen vor: *V. diffusa, V. mearnsii, V. betonicifolia, V. inconspicua,* und *V. philippica;* auf Mindoro nur *V. betonicifolia;* auf Negros nur *V. mearnsii.* Auf den nördlichen Teil Luzons sind also beschränkt: *V. arcuata, V. semilunaris, V. ramosiana, V. merrilliana,* und *V. rupicola.* Sämtliche Arten kommen nicht unter 2,000 bis 3,000 Fuss Meereshöhe vor; im

[1] Beih. Bot. Centralbl. 34–36 (1916–1918), Abteil. 2, und in Englers Bot. Jahrb. 54, Beibl. 120 (1917); an letzter Stelle sind *Viola Patrinii* und ihr ähnliche Arten besprochen.

nördlichsten Teile der Insel Luzon könnten sie vielleicht tiefer hinabsteigen.

Pflanzengeographische Beziehungen zu den Nachbarländern lassen sich in folgender Weise feststellen:

1. Durch *V. arcuata* zu Westjava, Sumatra und dem südöstlichen Asien; *V. arcuata* ist von Borneo und Celebes ausgeschlossen.

2. Durch *V. semilunaris* zu Japan; diese Art ist bisher nur aus Mittel- und Nordjapan bekannt.

3. Durch *V. diffusa* zu Hinterindien, China, Formosa, und Japan; *V. diffusa* ist von den Sundainseln noch nicht bekannt.

4. Durch *V. mearnsii*, die in Verwandtschaft der *V. selkirkii* Pursh gehört und der *V. boissieuana* Makino nahe steht, zu Japan.

5. Durch *V. betonicifolia* zu Südjapan, Formosa, Ostchina, Celebes, Timor, Java, und weiterhin zu Queensland, Neu-Südwales, Victoria, Tasmania (Australien). Die Art ist von der Insel Neu-Seeland ausgeschlossen; es muss auch erwähnt werden, dass ihr Vorkommen in Südjapan und auf Java noch nicht völlig unzweifelhaft begründet ist.

6. Durch *V. inconspicua* zu Java, Sumatra, und Südchina.

7. Durch *V. philippica* zu Java, China, Formosa, und Japan. Zu Borneo bestehen keine pflanzengeographischen Beziehungen.

Viola merrilliana, ramosiana, und *rupicola,* sowie *mearnsii* sind für die Philippinen endemisch.

MORPHOLOGIE DER ARTEN

Viola arcuata und *semilunaris* gehören, wie leicht zu erkennen ist, einer Verwandtschaftsgruppe an, den Bilobatae:[2]

Stylus ad basin ± geniculatus, clavatus, ad apicem utrinque lobato-marginatus, antice ad loborum basin rostratus; species acaules, stonoles ± erectos cauliformes rarissime radicantes emittentes.

Diese Gruppe ist von mir ausführlich bearbeitet.[3]

Ebenfalls ausläufertreibende Arten sind V. *merrilliana, diffusa,* und *rupicola.* Ihre Ausläufer liegen an der Erde—bei *V. diffusa* aber auch ± aufrecht—bilden an ihren Enden wurzelnde Rosetten und damit neue Pflanzen. Eine derartige Rosettenbildung habe ich auch bereits in der Gruppe Bilobatae beobachtet. Da nun der Stylus der drei letzten Arten auch eine Aehnlichkeit mit dem Stylus der Bilobatae aufweist, so besteht wahrscheinlich

[2] Becker, W., Beih. Bot. Centralbl. 34[2] (1916) 226.
[3] Loc. cit.

eine gewisse Verwandtschaft mit den Arten dieser Gruppe. Eine endgültige Entscheidung über die systematische Gruppierung dieser Arten verschiebe ich auf spätere Zeit.

Viola rupicola Elmer wurde das erste Mal ohne Ausläufer gesammelt und daher als ausläuferlose Art beschrieben. In Wirklichkeit entwickelt sie lange, sehr dünne Ausläufer, wie sie von *Merrill* unter *Nr. 7765* gesammelt sind. Die Folge des Irrtums war, dass ich *V. rupicola* [4] in die Verwandtschaft der *V. selkirkii* stellte und die *Nr. 7765* [5] als neue Spezies "*V. effusa*" publizierte. *V. rupicola* Elmer und *V. effusa* W. Bckr. sind aber sicher dieselbe Art, und letztere ist also Synonym zur ersteren. *Merrill Nr. 7765* bietet die Art in stat. flor., während Elmers Originale in stat. fruct. gesammelt sind.

Die übrigen vier Arten sind stengellos. Von ihnen gehört *V. mearnsii* zur Verwandtschaft der *V. selkirkii* Pursh, während *V. betonicifolia, inconspicua,* und *philippica* einander näher stehen und in dem weiteren Formenkreis der *V. patrinii* DC. gehören.

Sämtliche Arten gehören zur Violen sektion *Nomimium* Ging.[6] und zwar zur subsect. *Plagiostigma* Godr.[7]

Bestimmungstabelle.

1. Pflanze ausläufer- oder stengeltreibend ..... 2.
   Pflanze keine Ausläufer oder Stengel entwickelnd; Ausläufer bei *V. mearnsii* bisweilen vorhanden, vielleicht sich erst später entwickelnd .. 6.
2. Blätter kahl, höchstens mit sehr zerstreuten, kurzen Härchen an den Blattlappen oberseits;
   a^1. Basalbucht sehr breit offen ..... 3.
   a^2. Basalbucht ± eng, Pflanze zart ..... 7. V. ramosiana W. Becker.
   Blätter deutlich behaart, mindestens oberseits ..... 4.
3. Blätter 2 bis 3 cm lang und breit; Blattrand ziemlich geradlinig zur Spitze verlaufend, Blattrand sehr flach gekerbt, Blattlappen oberseits kahl ..... 1. V. arcuata Blume.
   Blätter 1 bis 1.5 cm lang und breit, selten etwas grösser; Blattrand schwach gebogen zur Spitze verlaufend, flach gekerbt; Blattlappen oberseits kurz behaart.
   2. V. semilunaris W. Bckr. var. philippinarum W. Becker.
4. Blätter am Grunde deutlich herzförmig, im Umrisse breit eiförmig bis rundlich, ± zugespitzt, dünn ..... 5.
   Blätter am Grunde in den Stiel verschmälert oder schwach herzförmig, breit eiförmig bis länglich, an der Spitze stumpf, ziemlich derb, dicht grau behaart ..... 5. V. diffusa Ging.

[4] Beih. Bot. Centralbl. 34[2] (1917) 415.
[5] Op. cit. 424.
[6] Mém. Violac. (1823).
[7] Fl. Lorraine Ed. 2 (1857) 86.

Blätter kürzer, ± rundlich, an der Basis schwach herzförmig. subsp. **tenuis** W. Becker.

5. Blätter dünn, häutig, auf der gesamten Oberseite lang weisshaarig; Ausläufer sehr lang, dünn, wurzelnd; Blätter auf der Unterseite an den Nerven deutlich behaart..... 4. **V. rupicola** Elmer.
Blätter besonders gegen den Rand der Oberseite behaart, auf der Unterseite kahl oder fast kahl; Ausläufer ± aufrecht. 3. **V. merrilliana** W. Becker.

6. Pflanze klein, zart; Wurzelstock dünn mit vielen Faserwurzeln; Blätter klein, selten bis 2 und 3 cm lang und breit, aus herzförmiger Basis breit dreieckigeiförmig, kaum länger als breit. 6. **V. mearnsii** Merrill.
Pflanze grösser, 10 bis 15 cm hoch; Wurzelstock meist kräftig, mit wenigen derberen Seitenwurzeln; Blätter deutlich länger als breit, meist mehr als 4 cm lang..... 7.

7. Sporn deutlich länger als die kurzen Kelchanhängsel, 6 bis 7 mm lang. 10. **V. philippica** Cavanilles.
Blätter an der Basis herzförmig..... subsp. **malesica** W. Becker.
Sporn nicht oder kaum länger als die Kelchanhängsel..... 8.

8. Sporn sehr kurz, die kurzen Kelchanhängsel kaum überragend; Blätter aus ± gestutzer oder verschmälerter, eckiger Basis lang vorgezogen. 8. **V. betonicifolia** Sm. subsp. **nepalensis** W. Becker.
Sporn ungefähr 3 mm lang, die sehr deutlichen, verlängerten und gezähnten Kelchanhängsel nicht überragend; Blätter aus offen herzförmiger, breiter Basis allmählich geradlinig zur Spitze verschmälert; häufig kleistogam blühend..... 9. **V. inconspicua** Blume.

BESPRECHUNG DER ARTEN

1. **VIOLA ARCUATA** Blume Bijdr. 1 (1825) 58; Korth. in Nederl. Kruidk. Arch. 1 (1848) 357; Miq. Fl. Ind. Bat. 1[2] (1859) 114; Oudem. in Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 75; Koorders Exefl. Java 2 (1912) 629, excl. syn. *V. glaucescens* et *japonica* et al. dub. et loc. "Tengger;" W. Bekr. in Beih. Bot. Centralbl. 34[2] (1916) 220–222, 226.

Viola distans Wall. in Trans. Med. Soc. Calc. 7 (1835) 227; Hook. f. Fl. Brit. Ind. 1 (1875) 183, excl. var. 2 et 3; Trimen Handb. Fl. Ceyl. 1 (1893) 66; Watt in Journ. Linn. Soc. Bot. 18 (1881) 380.
Viola Wightiana var. *glabra* Thwaites Enum. Pl. Ceyl. (1859) 20.
Viola Toppingii Elmer Leafl. Philip. Bot. 2 (1908) 504.

Planta glabra; caulibus flagellaceis, decumbentibus vel ascendentibus vel suberectis, 20 ad 40 cm longis; stipulis caulinis lanceolatis, parvis, subintegris, foliis semiorbiculato-reniformibus, acutiusculis, in venis utrinque ciliatis. Rhizoma tenue vel suberassiusculum, obliquum, articulatum, folia caulesque emittens. Stipulae caulinae virides, 5 ad 7 mm longae, lanceolatae, acutae, remote et indistincte denticulatae. Folia e basi profunde et aperte cordata sinibus rotundatis reniformia vel late ovata, subacuta, indistincte crenata, lobis basilaribus elongatis,

rotundatis, glabra, tantum ad nervos basilares interdum subciliata, supra subobscuro-viridia; basilaria longe petiolata. Flores longe pedunculati, parvi; sepala ovato-lanceolata vel lanceolata, acuta vel acuminata, circiter 2.5 mm longa, breviter appendiculata; petala pallide violacea, 8 ad 10 mm longa, lateralia glabra vel verosimiliter plerumque subbarbata, infimum brevissime calcaratum, calcar 2 mm longum et crassum; ovarium glabrum; stylus basi geniculatus, versus apicem clavatus, apice utrinque lobato-marginatus, antice ad loborum basin rostratus; capsula oblonga, glabra, circiter 5 mm longa. Fl. I-III.

LUZON, Benguet Subprovince, Baguio, *Elmer 6042, 8649, Topping 119.* Eine häufige Art, die an feuchten, freien Orten in der Nähe von Bächen und Flüssen wächst und oft dichte, zusammenhängende Matten bildet.

Sonstige Verbreitung: Java (reg. class.), Sumatra, Burma, India (Khasia Hills, Nilagiri Hills) Ceylon, China (Szetschwan, Kwangtung).

In Java sind die Nebenblätter eiförmig bis lanzettlich,± gezähnt und 1 bis 1.7 cm lang.

2. **VIOLA SEMILUNARIS** W. Bckr. in Beih. Bot. Centralbl. 34 [2] (1916) 231.
Viola verecunda β semilunaris Maxim. Mél. Biol. 9 (1876) 750; Bull. Acad. Sci. Petersb. (1877) 335; Franch. et Sav. Enum. Pl. Jap. 2 (1879) 648; Matsum. Enum. Pl. Jap. 1 (1912) 381.

Planta gracilis, glabra, caulibus paucis tenuibus flagellaceis erectis usque ad 25 cm altis. Rhizoma crassiusculum, obliquum, articulatum, folia caulesque emittens. Stipulae caulinae parvae, lanceolatae vel lineares, subintegrae, usque ad 7 mm longae, plerumque breviores. Folia basilaria longe petiolata, caulina remote inserta, 2 ad 3 cm longa et 2 ad 2.5 cm lata; inferiora e basi semi-aperte cordata, rotundato-ovata, obtusiuscula; superiora e basi semilunari± late aperta et profunde cordata, rotundiusculo-ovata vel triangularia, lobis elongatis; omnia supra ad nervos basilares plerumque albido-hispidula, plane crenata. Flores minores, dilute colorati; sepala anguste lanceolata, breviter appendiculata; petala lateralia barbata, infimum brevissime calcaratum; ovarium glabrum; stylus basi geniculatus, versus apicem clavatus, apice deplanatus et utrinque lobato-marginatus et antice ad loborum basin rostratus. (Descr. plantae Japon.)

Exs: Maxim. It. sec. Jap.: Hakodate (a. 1861 et 1866) p. p.; Faurie Pl. Jap. 6988, 2481.

Hab: Japonia media et borealis.

Auf den Philippinen nur die:

Var. PHILIPPINARUM W. Bckr. loc. cit.

Folia parva, circiter 1 ad 1.5 cm longa et lata; caules flagellacei ascendentes, plerumque humiliores. Fl. verosimiliter V-VI.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 4363, 4388 Mearns, Merrill 4769, Loher 1646* (herb. Calcutta), in Sümpfen, 2,300 m. s. m.

3. VIOLA MERRILLIANA W. Bckr. in Beih. Bot. Centralbl. 34 [2] (1916) 234.

Planta humilis, acaulis, stolones radicantes tenues emittens. Rhizoma tenue, 2 ad 3 mm crassum, subelongatum, 2 ad 5 cm longum, distincte articulatum, ± obliquum. Stolones elongati, 10 ad 20 cm longi, tenues, foliati, denique radicantes et plantas novellas formantes. Folia longe petiolata, parva e basi ± profunde cordata rotundato-ovata acutiuscula vel triangulariter ovata, subacuminata, supra praecipue ad margines albido-strigosa et in medio subglabra, subtus glabra nervis prominentibus, plane et indistincte crenata; folia ad stolones aequaliter disposita, ad fines radicantes rosulata. Stipulae virides, liberae, e basi ovata lanceolatae, longe acuminatae, remote fimbriatae. Flores parvi, folia superantes, in pedunculis supra medium bracteolatis; sepala ovato-lanceolata, acuta, trinervia, appendicibus brevibus 2.5 ad 3.5 mm longis; petala oblongo-obovata, alba, violaceo-striata, lateralia subbarbata, infimum abbreviatum naviculare brevicalcaratum; calcar saccatum, appendices calycinas paullum superans; ovarium glabrum; stylus basi distincte sigmoideo-curvatus, versus apicem clavatus, apice bilobato-marginatus antice breviter rostratus. Folia 1 ad 2 cm longa, 0.8 ad 1.7 cm lata; petioli 2 ad 4 (ad 6) cm longi; petala 8 ad 12 mm longa. Fl. I-V.

LUZON, Benguet Subprovince, Mount Pulog, *For. Bur. 16219, 16063 bis Curran, Merritt & Zschokke, Merrill 6503, 6493:* Lepanto District, Mount Data, *Merrill 4509, 4565,* alt. 2,000 bis 3,000 m. s. m.

Viola merrilliana ist durch die gegen den Rand hin deutlich behaarten Blätter sehr ausgezeichnet.

4. VIOLA RUPICOLA Elmer Leafl. Philip. Bot. 1 (1908) 324.
Viola effusa W. Bckr. in Beih. Bot. Centralbl. 34 [2] (1917) 424.

Planta acaulis, humilis, longe stolonosa; foliis minoribus, membranaceis, cordato-ovatis, supra in tota pagina albido-strigosis. Rhizoma subcrassiusculum, brevissime articulatum, reliquiis stipularum fuscis obsitum, subperpendiculare vel obliquum. Stipulae lanceolatae, 5 ad 6 mm longae, fuscae vel fusco-viri-

dulae, remote longifimbriatae. Folia ± longe petiolata, e basi anguste et profunde cordata ovata vel rotundiusculo-ovata, subacuminata vel acutiuscula, plane crenata, supra in tota pagina distincte albido-strigosa, subtus tantum ad nervos longe albido-strigosa, 1.5 ad 2 cm longa et 1 ad 1.7 cm lata; petioli tenues, subalati, praecipue in parte suprema dense albido-pilosa. Stolones longi, tenues, procumbentes, plerumque ad nodos non foliati at stipellati et saepe radicellati, ad nodos nonnullos rosulas formantes, e quibus plantae novae oriuntur. Flores folia superantia, inconspicui, ± albi, in pedunculis sublonge bracteolatis; sepala ovato-lanceolata, acutiuscula, subciliata, appendicibus truncatis vel rotundatis et strigosis; petala oblonga, lateralia longe barbata, infimum breviter calcaratum; calcar appendices calycinas vix superans, subtenue; ovarium glabrum, globosum, stylus apice deplanatus, curvatus, antice rostellatus, pone utriusque lobato-marginatus, rostello distincto horizontali antice subsursum directo. Fl. V.

LUZON, Benguet Subprovince, *Merrill 7765*, in Bergschluchten an den Gebirgspfaden, alt. 2,000 m 45 km nördlich von Baguio; *Elmer 8574*, ungefähr 3 km westlich von Baguio in feuchtem Moose auf Kalkstein in stat. fruct. (loc. class.).

Diese Art ist durch die dünnen, langen Ausläufer und die Rosettenbildung an den Ausläufern ausgezeichnet. Zuerst wurde sie ohne Ausläufer gesammelt und daher in der Diagnose von Elmer als ausläuferlos beschrieben.

5. **VIOLA DIFFUSA** Ging. in DC. Prodr. 1 (1824) 298; Franch. Pl. David. 1 (1884) 43, 2 (1888) 20, Pl. Delavay. (1889) 72; Diels Fl. Centr. China (1901) 477; Benth. Fl. Hongk. (1861) 20; Oudem. in Ann. Mus. Bot. Ludg.-Bat. 3 (1867) 77; de Boissieu in Bull. Herb. Boiss. II 1 (1901) 1077; Matsumura Enum. Pl. Jap. 2 (1912) 372; Makino in Bot. Mag. Tokyo 19 (1905) 73; Hook. f. Fl. Brit. Ind. 1 (1875) 183; Forbes and Hemsl. in Journ. Linn. Soc. Bot. 23 (1886) 52; Maxim. Mél. Biol. 9 (1876) 735; Act. Hort. Petropol. 11 (1890) 61; Matsum. et Hayata Enum. Pl. Formos. (1906) 28; Hayata Ic. Pl. Formos. 1 (1911) 60; Lecomte Fl. Gén. Indo-Chine 1 (1908) 208.

Viola tenuis Benth. in Hook. Lond. Journ. Bot. 1 (1842) 482; Champ. et Benth in Hook. Journ. Bot. Kew Miscel. 3 (1851) 260.

Viola kiusiana Makino in Bot. Mag. Tokyo 16 (1902) 138, 19 (1905) 73.

Planta annua (semper?), acaulis, stonifera, ± pilosa. Radix verticalis, ± tenuis, fibrillosa, albida. Stolones saepe substricte suberecti, ± numerosi, usque ad 15 cm longi, posterius radicantes, in parte inferiore et media stipulis vel foliis muniti, ad finem dense foliati et floriferi. Stipulae lineari-lanceolatae, longe fimbriatae, pallide virides, in parte infima adnatae, 6 ad 12 mm

longae. Folia basilaria majora usque ad 8 cm longa, stolonum minora, ± late ovata, obtusiuscula, in petiolum fere aequilongum vel sublongiorem decurrentia vel basi subtruncata, plane crenata; in subspec. rotundiuscula, basi cordata, ± longe petiolata, lamina minore. Flores inodori, longe pedunculati, basilares et in stolonibus, parvi, circiter 7 mm longi vel minores; sepala lanceolata, trinervia, acute, breviter appendiculata; petala oblongo-obovata, pallide violacea vel albido-purpurea, lateralia ebarbata, infimum brevissime calcaratum; calcar appendices calycis non vel vix superans, 1 ad 2 mm longum, subtenue; stylus clavatus, apice bilobus, antice inter lobulos breviter rostellatus; capsula parva, glabra. Fl. XI. et posterius, probabiliter toto anno.

LUZON, Lepanto Subprovince, Balili (Mount Data), *Merrill 4612;* wächst in Felsspalten der Kaffeeplantagen-Terrassen alt. 2,000 m; Bontoc Subprovince, Mount Pukis, *Bur. Sci. 37796 Ramos & Edaño.*

Sonstige Verbreitung: Indien, China, Tonkin, Japan, Formosa; auf Feldern, in Culturen, an Wegrändern, in gemässigtem Klima, 500 bis 2,000 m.

Im östlichsten Teile des Areales, in dem auch der Typus auftritt, kommt eine kleinblättrige Form vor, die durch eine ± rundliche oder eiförmige, an der Basis ± herzfömige Lamina ausgezeichnet ist. Sie tritt bereits in der Flora von Hongkong (Victoria Peak 400 m) auf und entspricht der *V. tenuis* Benth. l. c. Ich habe sie deshalb als subsp. *tenuis* bezeichnet. Vielleicht hat sie nur den Wert einer Varietät. *V. nagasawai* Makino et Hayata[8] dürfte mit ihr völlig identisch sein.

Subsp. TENUIS W. Bckr. subsp. nov.

Viola tenuis Benth. l. c., Champ. et Benth. l. c.
Viola diffusa Mats. et Hay. l. c. quoad pl. Formos.; Hay. l. c.

Folia rotundiuscula vel ovata, ± obtusa, basi ± distincte cordata, majora vel minora, ± longe petiolata.

LUZON, Lepanto District, Mount Data, *Merrill 4562.* MINDANAO, Davao Subprovince, Todaya, Mount Apo, *Elmer 11544* in herb. Leyden sub. nom. *Viola apoensis* Elm., folia e basi anguste et profunde cordata rotundata, obtusa, rotundato-paucicrenata, longipetiolata; planta 4 ad 6 cm alta.

[8] Journ. Coll. Sci. Tokyo 22 (1906) 30 [= Matsum. et Hay. Enum. Pl. Formos. (1906) 30].

Merrill gibt auf der Scheda die Beschaffenheit des Standortes genauer an: feuchter Boden, im Regenwalde, Höhenlage 2,300 m. Hier scheint die Pflanze ausdauernd zu sein.

6. VIOLA MEARNSII Merrill in Philip. Journ. Sci. 5 (1910) Bot. 201; W. Bckr. in Beih. Bot. Centralbl. 34[2] (1917) 411.

Planta nana, in omnibus partibus parva, munda, acaulis. Rhizoma tenue, verticale vel ± obliquum, 1 ad 2 cm longum, breviter articulatum vel sublaeve, probabiliter rarius stolones caulescentes abbreviatos ± erectos potius abnormales emittens. Stipulae lineari-lanceolatae, acuminatae, 3 ad 5 mm longae, infra medium adnatae, breviter glanduloso-fimbriatae. Folia e basi ± profunde et aperte cordata late triangulariter ovata, lobis sinibusque rotundatis, subacuminata, obtusa, glabra, distincte remote crenata, ad crenas pilis, nonnullis munita (interdum tantum sub microscopio visis), longe petiolata. Flores folia ± superantes, parvi, in pedunculis tenuibus plerumque ultra medium bracteolatis; sepala lanceolata, acuminata, trinervia, appendicibus distinctis denticulatis; petala albida, violaceo-striata, oblongo-obovata cum calcari 9 ad 10 mm longa, lateralia papilloso-barbata, infimum abbreviatum breviter calcaratum; calcar appendices calycinas distincte superans, crassiusculum, apice rotundatum, 1.5 ad 2 mm longum, ovarium glabrum; stylus basi sigmoideo-curvatus, clavatus, deplanatus, marginatus, distincte rostratus; capsula globosa. Fl. IV-VI.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 4310 Mearns, Bur. Sci. 8430 McGregor, Merrill 6625*, alt. 2,300 m; Suyoc bis Pauai, *Merrill 4790:* Laguna Province, Mount Banahao, *Bur. Sci. 9781, 9851 Robinson*, alt. 800 und 2,200 m. NEGROS, Canlaon Volcano, *Merrill 9851*. MINDANAO, Misamis Province, Mount Malindang, *For. Bur. 4625 Mearns & Hutchinson* (loc. class.): Davao District, Mount Apo, *Elmer 11543* (herb. Hamburg und Leyden). An schattigen Hängen der Wasserläufe, an Felsen schattiger Schluchten, auf feuchten Wiesen, 800 bis 2,300 m. s. m.

Folia 1 ad (rarius) 3 cm longa, 1 ad (rarius) 2.5 cm lata; petioli 2 ad 6 cm longi; crenae fol. 5 ad 8; stipulae 3 ad 5 mm longae.

Die Art steht der *Viola boissieuana* Makino in Bot. Mag. Tokyo 16 (1902) 127 nahe, gehört daher auch in den Verwandtenkreis der *V. selkirkii* Pursh.

7. **VIOLA RAMOSIANA** W. Bckr. sp. nov. ex affinitate *V. mearnsii* Merrill.

Planta nana, glaberrima, in omnibus partibus major quam V. Mearnsii, acaulis, stolonifera. Rhizoma tenue, verticale vel ± obliquum, 1 ad 2 cm longum, sublaeve, fibrillosum, stolones tenues foliatos horizontales emittens. Stolones saepe complures, longius articulati, ad nodos folia floresque praebentes, ad finem rosulam foliorum non ostendentes. Stipulae liberae, e basi ovato-lanceolata longe acuminatae, remote glanduloso-fimbriatae, usque ad 1 cm longae, membranaceae, pallide virides, interdum subfuscae. Folia basilaria e basi profunde cordata ovata usque oblongo-ovata, 2 ad 3 cm longa, 1.5 ad 1.8 cm lata, obtusiuscula, glaberrima, lobis sinibusque rotundatis, distincte rotundato-crenata, ad crenas distincte incisas et substipitato-glandulosas sub microscopio interdum pilis nonnullis munita, petiolo subaequilongo. Folia stolonum minora, breviora, basi subaperte cordata, subacutiuscula. Flores folia vix vel non superantes, in pedunculis tenuibus circiter in medio bibracteolatis infra corollam disparse hirsutis; sepala lanceolata, acuminata, trinervia, ad margines ciliata, ad apicem glandula munita, 2.5 mm longa, appendicibus abbreviatis; petala?; capsula ovoidea, glabra, 5 mm longa; stylus?

LUZON, Kalinga Subprovince, Lubuagan, Mount Masingit, *Bur. Sci. 37548 Ramos & Edaño* ad ripas circiter 1,350 m in stat. fruct. II 1920.

A Viola mearnsii stolonibus horizontalibus bene evolutis, foliis glaberrimis ovatis vel oblongo-ovatis obtusiusculis majoribus, pedunculis infra corollam disparse hirsutis, sepalis ad margines ciliatis et appendicibus calycinis abbreviatis diversa est.

Viola mearnsii und *V. ramosiana* sind durch die mit einer Drüse endigenden Sepalen ausgezeichnet. *V. mearnsii* ist einmal mit sehr kurzen Stolonen gesammelt (Benguet Provincia, Pauai, *For Bur. 4310 Mearns*, W. Becker. Herb. Viol.).

8. **VIOLA BETONICIFOLIA** Sm. in Rees. Cyclop. 37 (1817) No. 7.

Viola Patrinii var. *napaulensis* Ging. in DC. Prodr. 1 (1824) 293.

Viola Patrinii Wight et Arn. Prodr. Fl. Ind. Or. 1 (1834) 32; Hook. f. Fl. Brit. Ind. 1 (1875) 183 p. p.!; Forbes et Hemsl. in Journ. Linn. Soc. Bot. 23 (1886) 53 p. p.!; Trimen Handb. Fl. Ceyl 1 (893) 66; Diels Fl. Centr. Chin. (1901) 476 p. p.; Koorders Excfl. Java 2 (1912) 627 p. p. minima!

Viola Patrinii var. *laotiana* De Boissieu in Bull. Soc. Bot. France 55 (1908) 467.

Viola Patrinii var. *typica* Maxim. in Bull. Acad. Sci. Pétersb. 23 (1877) 315 p. p.!

Viola caespitosa Don Prodr. Fl. Nepal. (1825) 205.
Viola Walkeri Wight Illustr. Ind. Bot. 1 (1840) 42, *t. 18* (tab. falso sub. nom. *V. Patrinii*).
Viola nilagirica Turcz. in Bull. Soc. Nat. Mosc. 36[1] (1863) 556.

Planta acaulis, estolonosa, glaberrima, plerumque caespitosa; foliis elongato-triangularibus; floribus minoribus, brevissime calcaratis. Rhizoma obscure coloratum, radicibus fere ex uno loco exeuntibus obsitum. Stipulae usque longo ultra medium adnatae, fuscae. Folia plerumque numerosa, ± longe petiolata, glaberrima, e basi truncata vel cuneata in petiolum alatum angustata subhastata elongato-triangularia, indistincte plane crenata, obtusiuscula. Flores circiter 1 cm longi, violacei vel pallide violacei vel albidi, folia non vel non multum superantes; sepala ovato-lanceolata, acuminata, appendicibus subconspicuis; petala obscure lineata, lateralia distincte barbata; calcar brevissimum, subrecurvatum; ovarium glabrum; stylus clavatus, apice deplanatus, praecipue pone marginatus. Fl. VIII-IV.

Die Pflanze der Philippinen gehört zur:

Subsp. **NEPALENSIS** W. Bckr. in Engl. Bot. Jahrb. 54 (1917) Beibl. 120: 166.

LUZON, Cagayan Province, *For. Bur. 17095 Curran*, alt. 30-50 m: Benguet Subprovince, Baguio, *For. Bur. 5097, 10940 Curran, Bur. Sci. 2767, 2472 Mearns*, alt. 1,400 m: Lepanto Subprovince, Suyoc to Cervantes, *Merrill 4452*, alt. 1,300 m: Mount Data, *Merrill 4499*: Bontoc Subprovince, Bauco, *Vanoverbergh 229*. MINDORO, Mount Sablayan, *For. Bur. 9771 Merritt*, alt. 850 m. MINDANAO, Bukidnon Subprovince, Tankulan, *Bur. Sci. 21464 Escritor, Weber 1502*, verbreitet von Tankulan bis Malaybalay, *Worcester;* Sumilao, *Bur. Sci. 15707 Fénix*. Auf offenen, grasigen Plätzen, Abhängen der Fichtenregion.

Sonstige Verbreitung der subsp. *nepalensis:* China, Formosa, Japan, Celebes, Timor, Java, Burma, Assam, Himalaya, Afghanistan, Vorder-Indien, Ceylon.

Ich habe schon nachgewiesen,[9] dass *V. patrinii* DC. nur in Sibirien (vom oberen Jenissei bis Transbaikalien), im Amurgebiet, bei Wladiwostok und in Japan vorkommt, dass sie eine Pflanze feuchter Standorte ist, die auch von der sonst als *V. patrinii* für gewöhnlich bezeichneten Spezies des südlichen und südöstlichen Asiens wesentlich verschieden ist. Letztere bildet mit der australischen *V. betonicifolia* Sm. entschieden eine

[9] Engl. Bot. Jahrb. 54 (1917) Beibl. 120: 156–166.

morphologische Einheit. Deshalb muss sie als *V. betonicifolia* Sm. bezeichnet werden. Die Gesamtart zerfällt in die subsp. *nepalensis* und *australensis* W. Bckr.[10] Beide Unterarten stehen sich sehr nahe. Bis zum Beginn des Tertiärs müssen sie ein kontinuierliches Areal gehabt haben. Da sich das jetzige Areal nicht auf Neu-Seeland erstreckt, darf man annehmen, dass die Einwanderung nach Australien erst nach der frühzeitigen Abtrennung Neu-Seelands vom australischen Kontinente erfolgte. Nach der heutigen Verbreitung erfolgte die Einwanderung nach Australien über die Philippinen, Celebes, und Timor. Die Gebiete westlich von Celebes (Borneo, Sumatra, mittleres und südliches Hinter-Indien) liegen ausserhalb des heutigen Areales und sind anscheinend nie von der Art bewohnt worden. Auf Java ist sie anscheinend selten und kommt dort vielleicht nur in einem Teile vor (Bromo 2,300 m, leg. *O. Kuntze*).

9. VIOLA INCONSPICUA Blume Cat. Gew. Buitenz. (1823) 57, Bijdr. 1 (1825) 58; Korth. in Nederl. Kruidk. Arch. 1 (1848) 357; Burgersd. in Miq. Pl. Junghuhnianae (1851) 118; Miguel Fl. Ind. Bat. 1[1] (1859) 112 et 686; Oudem. in Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 78; W. Bckr. in Engl. Bot. Jahrb. 54 (1917) Beibl. 120: 167–174.

Viola primulifolia Roxb. Fl. Ind. ed. 2, 1 (1832) 650, ed. 3 (1874) 218.

Viola apetala Roxb. Fl. Ind. 2 (1824) 449, ed. 2, 1 (1832) 650, ed. 3 (1874) 218.

Viola Roxburghiana Voigt Hort. Suburb. Calcutt. (1845) 76.

Viola trinervis Korth. in Ned. Kruidk. Arch. 1 (1848) 357.

Viola Patrinii Hook. f. Fl. Brit. Ind. 1 (1875) 183 p.p.; Baker Fl. Mauritius Seych. (1877) 10, verosimiliter.

Viola Patrinii Ging. var. *typica* De Boiss. et Capit. in Bull. Soc. Bot. France (1910) 340, quoad pl. Assam.; Koorders Excfl. Java 2 (1912) 626, p.p. maxima.

Viola Patrinii Ging. var. *triangularis* Franch. et Savat. Enum. Pl. Jap. 2 (1879) 283, forsitan.

Viola betonicaefolia Boj. Hort. Maurit. (1837) 20, verosimiliter.

Acaulis, perennis (vel etiam annua?), estolonosa. Rhizoma ± verticale, plerumque simplex et paullum ramosum, tenue vel ± crassum, elongatum, in parte suprema brevissime articulatum ex eo rugosum et ± crassatum, ceterum laeve. Stipulae usque ultra medium adnatae, fuscae, distincte abbreviatae, 7 ad 9 mm longae, 1.5 mm latae, laciniis angustis acuminatis extrorsum directis. Folia plerumque numerosa, rosulata, longe petiolata, e basi ± cordata sinibus rotundatis apertis hastata

[10] Op. cit. 166.

triangularia protracta subacuminata, lobis basalibus ± rotundatis, in medio subattenuata, obtusiuscula, crenato-serrata, plerumque glabra, supra subtilissime dense albido-papillosa, adulteriora nigrescenti-viridia. Flores in pedicellis elongatis, ± tenuibus, plerumque in parte superiore ± longe bracteolatis; sepala lanceolata, acuminata, trinervia, glabra; appendices calycinae angustatae, elongatae, praecipue inferiores saepius sepala aequantes, fine denticulatae, calcar dilute coloratum crassiusculum subrecurvatum distincte superantes; petala violacea, calc. inclus. 10 ad 12 mm longa, sepala non multum superantia, oblongo-obovata, lateralia barbata; ovarium glabrum; stylus basi geniculatus, versus apicem clavatus, apice deplanatus, disco antice oblique-deorsum directo (ex eo "stylo incurvo" apud Blume l. c.) utrinque distinctissime marginato distincte rostrato. Fl. chasmogam. XII-III., cleistogam. probabiliter toto anno.

LUZON, Cagayan Province, Abulug River, *For. Bur. 19622 Curran, Merrill Phil. Pl. 1097 leg. Ramos:* Benguet Subprovince, *Bur. Sci. 5899 Ramos.* MINDANAO, Lanao District, Camp Keithley, *Clemens 21,* alt. 700 m.

Sonstige Verbreitung: Java, Sumatra, Himalaya, Assam, Burma, Yunnan, Szetschwan, Kwangtung, Kiangsu; an Felsen und auch kultivierten Orten.

Ich habe die Art [11] ausführlich besprochen. Sie ist durch die Blattform, die sehr kurzen Nebenblätter, die stark verlängerten Kelchanhängsel und hervortretende Cleistogamität von *V. betonicifolia* Sm. sehr ausgezeichnet.

10. **VIOLA PHILIPPICA** Cav. Icon. 6 (1801) 19, *t. 529, f. 2;* Poir. in Lam. Encycl. 7 (1808) 629; Miq. Fl. Ind. Bat. 1 [1] (1859) 113.

Viola confusa Champ. ex Benth. in Hook. Journ. Bot. Kew Miscel. 3 (1851) 260; Benth. Fl. Hongk. (1861) 20.

Planta acaulis, estolonosa; stipulis usque ultra medium adnatis, pallidis; foliis cordato-triangulari-ovatis, subelongatis; floribus longe calcaratis. Rhizoma non crassum, potius tenue, radicibus tenuibus sublaevibus elongatis obsitum. Stipulae usque longe ultra medium adnatae, pallidae. Folia dilute virescentia, numerosa, e basi ± cordata ovata vel triangulariter ovata, subelongata, plane crenata, plerumque glabra vel subpubescentia, in petiolis circiter aequilongis in parte superiore alatis; lamina circiter 1 ad 2 cm lata, 2.5 ad 5 cm longa. Flores mundi, potius parvi, folia superantes, in pedunculis gracilibus 6 ad 10 cm longis; sepala ovato-lanceolata, acuminata, appendicibus

[11] Loc. cit.

subconspicuis; petala angusta, obovata, dilute violacea, basi obscurius colorata, lateralia indistinctissime barbata vel etiam ebarbata (?), infimum longe calcaratum; calcar gracile, 4 ad 5 mm longum; ovarium glabrum; stylus basi geniculatus, apice clavatus deplanatus utrinque distincte marginatus, antice breviter rostellatus. Fl. XI-I.

Die Pflanze der Philippinen gehört zur:

Subsp. MALESICA W. Bckr. in Engl. Bot. Jahrb. 54 (1917) Beibl. 120: 178.

Die Originaldiagnose der *Viola philippica* folgt:

"Viola acaulis foliis ovato-oblongis, obtusis, crenulatis, petiolo longioribus: scapis unifloris bibracteatis. Viola. *Née herbar.*

"Radix fusiformis barbata: caulis nullus. Folia numerosa, petiolis longiora, ovato-oblonga, obtusa, crenulata, subvillosa praesertim inferiore pagina, sesquipollicem longa, quattuor lineas lata: stipulae subulatae petiolo adnatae. Scapi plures, foliis longiores, tenues, uniflori, prope medium bibracteati bracteis lanceolatis. Calix pentaphyllus, foliolis ovato-lanceolatis persistentibus, quorum duo fulciunt petalum longius, duo par petalorum oppositorum huic proximorum, et quintum duo reliqua petala. Corolla pentapetala irregularis violaceo-rubra: petala ovata, apice obtusa, versus basim angusta, quorum unum ceteris longius, basi corniculatum, corniculo obtuso calicis foliolis longiore. Staminum filamenta quinque minima: antherae subconnexae, ovato-compressae, membranis ad apicem auctae. Germen liberum, oblongiusculum: stylus exertus, basi setaceus, postea infundibuliformis, deflexus, ore sistens apiculum brevem. Capsula oblonga, trigona, unilocularis, trivalvis, valvis medio seminiferis. Semina fusco-rubentia subglobosa. Habitat in Insula Luzon tertio a Manila lapide, ibique Oxalis sensitiva; Morinda axillaris; Iusticia nasuta; Mogorium sambac; Scirpus dipsaceus, barbatus, miliaceus et dichotomus. Vidi siccas in eodem herbario."

Die Pflanzen der Philippinen entsprechen nicht dieser Beschreibung; denn ihre Blätter sind Kahl und an der Basis herzförmig. Wohl aber stimmt die nördliche subspezies der *V. philippica,* die subsp. *munda,* mit ihr und der Abbildung gut überein. E. D. Merrill äussert sich [12] dahin, dass *V. philippica* Cav. nicht auf Material von den Philippinen gegründet sein kann; der Originalfundort, wie er bei Cavanilles angegeben ist, sei unmöglich, da er sich auf eine Veilchenart beziehen würde, die in Meereshöhe wachsen müsste; auf den Philippinen

[12] Philip. Journ. Sci. 10 (1915) Bot. 191.

käme aber kein Veilchen unter 600 bis 1000 m Höhe vor, ausser vielleicht am nördlichsten Ende von Luzon. Merrill vermutet dann, dass *V. philippica* Cav. aus Südamerika, Mexico, oder vielleicht sogar aus Californien stammt, da das Material der Malaspina Expedition bezüglich der Ursprungsländer gemischt war.

Er teilte mir auch in einem ausführlichen Bericht über die Malaspina-Expedition [13] (1789–1793), bei der Née und Haenke als Botaniker tätig waren,—in der Publikation der *V. philippica* Cav. ist "Née herbar." angegeben—, mit, dass diese Expedition besonders in Australien und auf Neu-Seeland umfangreiche Sammlungen gemacht hat. Ich muss aber feststellen, dass weder in Australien, auf Neu-Seeland und den Gesellschafts- und Marschallinseln, noch in Südamerika, Mexiko, und Californien eine der *V. philippica* ähnliche und verwandte Form vorkommt. Ich muss annehmen nach Abbildung und Beschreibung, dass *V. philippica* Cav. aus Ostasien stammt, und dass China oder Japan als Ursprungsländer in Betracht kommen. Da das Schiff der Expedition die "Atraveda" im März und April 1792, allerdings ohne die Naturwissenschaftler, Macao in Südchina anlief, so könnte man vielleicht annehmen, dass andere Mitglieder der Expedition die Pflanze von Macao mitgebracht hatten; ich muss aber darauf hinweisen, dass die mir von Macao bekannte *V. philippica* (Herb. Kopenhagen) der subsp. *malesica* angehört, während die Abbildung in Cav. l. c. deutlich auf die subsp. *munda* hinweist. Es ist also bis jetzt noch unklar, wie die Originalpflanzen in das Herb. Née hineingekommen sind. Eine einzige Pflanze von den Philippinen (District Lepanto, Bontoc, Suyoc, *Nr. 14448*) zeigt übrigens inmitten der breiteren Blätter einige schmale Blätter mit cune-

[13] Hauptdaten der Malaspina-Expedition: Abfahrt von Cadiz 30. Juli 1789 - Montevideo - Cap Horn - Westküste von Amerika bis Alaska - zurück bis Acapulco (Mexiko) - westlich durch den Grossen Ozean nach den Mulgrave-Inseln (Marschall-inseln) - Guam (Mariannen) - Philippinen - Fahrtdauer Acapulco bis Manila Januar 1792 bis März 1792 - die "Atraveda" ohne die Naturwissenschaftler am 31. März 1792 nach Macao in Südchina, Rückkehr am 19. Mai 1792 nach Manila - am 6. Nov. 1792 wurde Manila verlassen, Fahrt nach Zamboanga auf Mindanao - Rückkehr über Neu-Seeland, Sidney, Vavao (Tonga-Inseln), Callao (Peru), Cap Horn nach Spanien.- Das meiste von den Sammlungen auf den Philippinen stammt von Luzon; eine Expedition ging von Sorsogon in Süd-Luzon über Land nach Manila; eine andere Expedition von Manila nordwärts an der Westküste entlang zum nordwestlichen Teil der Insel, gelangte nicht sehr weit in des Innere; sonst nur Sammlungen auf Mindanao (Zamboanga) sec. Merrill. Weiterhin umfassende Sammlungen in Australia und Neu-Seeland; ausserdem wurde botanisiert auf den Mariannen, Gesellschafts - und Marschallinseln (Mulgrave-Insel).

ater Basis. Dass sich die Publikation der *V. philippica* Cav. auf die hier in Betracht kommende Gesamtart bezieht, ist nicht anzuzweifeln.

Verbreitung der subsp. *munda* W. Bckr. in Engl. Bot. Jarhb. 54 (1917) Beibl. 120: 175 (folia in summa lanceolata vel oblonga, basi cuneata vel truncata vel subcordata, plane crenata, pubescentia vel glabra): Mandschurei, Korea, Mongolei, nördliches, centrales und südwestliches China, Burma, Japan, Himalaya.

Sonstige Verbreitung der subsp. *malesica:* China (Kiangsu und Tschekiang, formae intermediae ad subsp. mundam vergentes;—*typ:* Fokien, Insel Matson, Canton, Hongkong, Macao), Ostindien (Langson), Formosa, Japan, Java.

Zum Schlusse erkläre ich meine Bereitwilligkeit, auch ferner Violen su bestimmen und zu bearbeiten. Ostasien stellt ein Hauptentwicklungscentrum des Genus *Viola* dar. Deshalb ist das genaue Studium der asiatischen Formen für ihre phylogenetischen Zusammenhänge äusserst wichtig und unerlässlich. Dieses Studium kann aber erst dann wertvolle Resultäte erbringen, wenn es auch stets Bezug nimmt auf das Ganze. Diese Beziehungen kann aber nur der Spezialist herstellen.

NACHTRAG

VIOLA EDAÑOII W. Bckr. sp. nov.

Acaulis, ex affinitate V. mearnsii Merr., major, estolonosa, glaberrima, foliis e basi semi-aperte cordata elongato-ovatis. Rhizoma subdebile, verticale, distincte breviter articulatum, in parte superiore subcauliforme, radicellis elongatis tenuibus obsitum, estolonosum, folia numerosa emittens. Folia circiter 7 ad 10, longe petiolata, cum petiolo 6 ad 8 cm longa, glaberrima; lamina 2 ad 3 cm longa et 1.5 ad 2 cm lata, e basi sinibus rotundatis semi-aperte cordata elongato-ovata vel triangulari-ovata, ± acutiuscula; margines subconvexi vel subdirecti, inciso-crenati, crenis glanduligeris et glandulis exsertis; crenae ad basin laminae saepe binae approximatae. Stipulae liberae, abbreviatae, membranaceae, virides, ovato-lanceolatae, longe acuminatae, versus apicem remote glanduloso-longifimbriatae. Flores in pedicellis gracilibus, circiter in medio breviter bracteolatis, in parte suprema subpilosis; sepala lanceolata, circiter 2 ad 3 mm longa, breviter appendiculata; petala ?; ovarium et stylus ?; capsula circiter 5 mm longa.

MINDANAO, Bukidnon Subprovince, Tankulan and vicinity, ad rupes torrentium in silvis alt. 3,600 m., *Bur. Sci. 39082 Ramos & Edaño,* VII. 8, 1920, in statu fruct.

SECONDARY SEXUAL CHARACTERS IN THE LOACH MISGURNUS ANGUILLICAUDATUS CANTOR

By KIKUO OKAMOTO

Of the Anatomical Institute of Keio University, Tokyo, Japan

ONE PLATE

Secondary sexual differences are common among mammals, birds, amphibians, and insects, as we know; for instance, in color, in size, and adornment. Among fishes there are scattered instances of such differences, but they are comparatively rare. Since the appearance of Cunningham's (1) work on *Cynolebias*, Regan (3) has published a paper on the sexual differences in *Cynolebias* but not on those of the Ostariophysi. While studying the intestinal respiration of loaches, at the suggestion of Prof. N. Yatsu, I observed the secondary sexual characters in them. According to the descriptions of Cunningham and others, the large size of the body is certainly one of the commonest of the secondary sexual differences in female fishes, while the strong pectoral fins are one of the commonest in the male. In addition to these I observed a remarkable difference; namely, a swelling on the posterior sides of the dorsal fin of the male fish. This swelling is more or less spindling or somewhat cylindrical in shape, tapering at each end and especially so caudad (Plate 1, fig. 1*a*). Its length is about 1 by 10 to 12 centimeters. This specific characteristic of the male distinguishes it markedly from the female.

In some Ostariophysi (for instance, a kind of Cyprinidæ), according to Cunningham's description, the males are distinguished by an enlargement, or swelling, of the anterior ray of the pectoral fins, especially in the spawning season; this swelling disappears soon after breeding has been accomplished. I have not observed this character in the loaches, nor does the swelling on the back disappear even after the breeding season. In what stage does the swelling begin to appear in the male loach? It appears as in other cases in mature fishes, according to my observation, in specimens more than 7 centimeters in length.

The second characteristic of the male consists in the enlargement of the pectoral fins and the elongated second ray of the

pectorals (Plate 1, fig. 1*b*). The pectoral fins of the male therefore differ in shape from those of the female. The pectoral fins are, relatively, one to one and a half times the length of the head in the male and half that in the female. The dorsal, the ventral, and the anal fins of the males are also relatively longer than those of the females, but they are not so remarkable as the pectoral fins.

It is well known that among many of the higher animals the sexes differ in size.(2) Thus in fishes the male generally averages smaller than the female. In loaches the males are so markedly smaller that in some cases they are not even half the size of the females. The difference in size of male and female loaches, obtained by measuring 100 specimens of each sex, is shown in Table 1.

TABLE 1.—*Measurements of loaches, one hundred specimens of each sex.*

Length of body.	Male.	Female.
	mm.	*mm.*
Average	101.27	110.02
Maximum	120.00	150.00

The body and fins of the male are, to all appearances, well adapted in size to active motion in the water. It will be interesting to investigate the nature and possible use of the spindly swelling on the back of the male loach.

MICROSCOPICAL OBSERVATION

The preparations were fixed in formalin and stained in hæmatoxylin eosin. Preparations from the corresponding parts of females were also made. According to my observation of the swelling, the male differs from the female in the following points:

The epidermis of the corresponding part of swelling of male preparations is thickened and contains many so-called *Kolbzelle*.

The dermal scale pouch (*Schuppentasche*) is enlarged and contains gelatinous tissue and fat cells.

A more remarkable adipose tissue is found between the dermal and muscle layers. Many melanin pigment cells are found among the fat cells. This adipose tissue has no noticeable capsule of connective tissue.

I paid special attention to the swelling to learn whether or not it is caused by a strong development of muscle layer, by which the ductus deferens might be compressed; my observation led to a negative answer. The true nature of such an adipose tis-

sue under the dermal layer and in the scale pouches is not exactly known. I shall investigate this point some time in the future.

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(1) CUNNINGHAM, J. T. Sexual dimorphism in the animal kingdom. (A theory of the evolution of secondary sexual characters.) London (1900).
(2) GEDDES and THOMSON. The evolution of sex (1901).
(3) REGAN, C. T. Sexual differences in the poeciliid fishes of the genus Cynolebias. Ann. & Mag. Nat. Hist. VIII 10 (1912) 641.

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ILLUSTRATION

PLATE 1

FIG. 1. Male and female loaches; the male showing a swelling, *a*, on posterior side of dorsal fin and strong pectoral fins with elongated second ray, *b*; × 0.75.

2. Cross section of the swelling on the male loach; *a*, fat cells in the scale pouch; *b*, fatty tissue; *c*, epidermis; *d*, corium; *e*, muscular layer; × about 40.

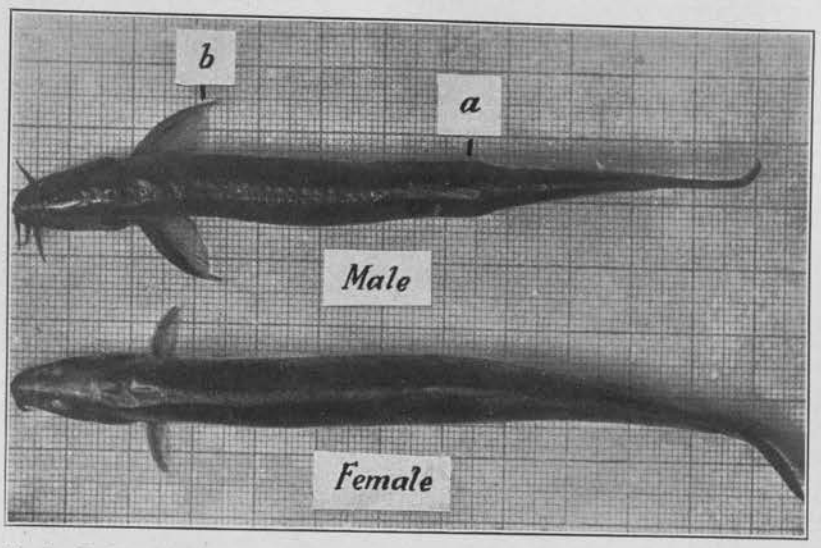

Fig. 1. Male and female loaches; the male showing a swelling, *a*, on posterior side of dorsal fin and strong pectoral fins with elongated second ray, *b*; × 0.75.

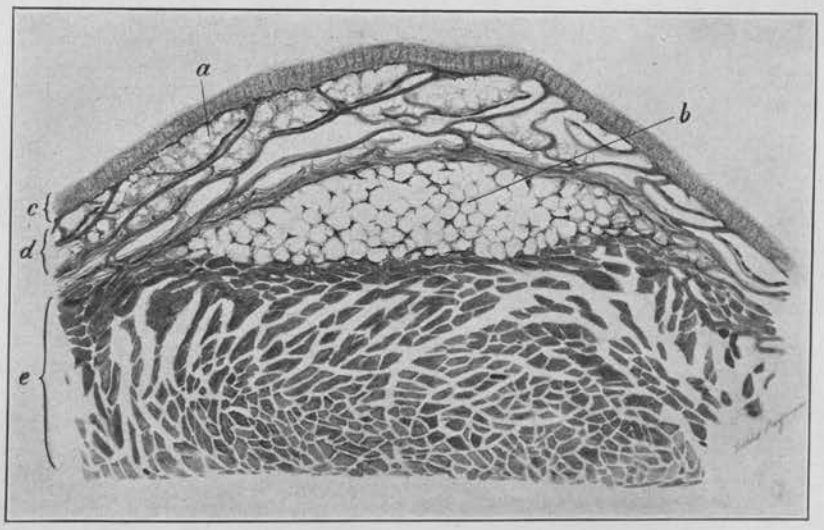

Fig. 2. Cross section of the swelling on the male loach; *a*, fat cells in the scale pouch; *b*, fatty tissue; *c*, epidermis; *d*, corium; *e*, muscular layer; × about 40.

PLATE 1.

THE STRUCTURE OF CHLORINE DIOXIDE AND RELATED COMPOUNDS[1]

By GRANVILLE A. PERKINS

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In a previous paper[2] the writer has discussed the interpretation of some of the older ideas of valence in terms based on the Lewis-Langmuir theory of valence. These interpretations are summarized in Table 1.

TABLE 1.—*Relations between the older "affinity unit" theory and the Lewis-Langmuir theory of valence.*

Affinity unit theory.	Example.	Nomenclature based on Lewis-Langmuir theory.	Example.
Affinity unit; nonmetallic unsatisfied bond.	Cl—	Vacancy for one electron in the shell.	Cl—
Affinity unit; metallic unsatisfied bond.	Na—	One loosely held electron.	Na^{I}
Negative ion	Cl^{-}—	Negative ion	Cl^{-}
Positive ion	Na^{+}—	Positive ion	Na^{+}
Single bond, not ionizable.	Cl—Cl	Single bond; direct union, two electrons in common.	Cl—Cl
Single bond, ionizable	Na—Cl	Salt-forming union	Na^{+}.....Cl^{-}
Auxiliary valence, ammonium type.	$(CH_3)_3{\equiv}N{<}^{CH_3}_{Cl}$	Increase of valence by ionization.	$(CH_3)_4{}^{-}N^{+}$....Cl^{-}
Auxiliary valence, amine oxide type.	$(CH_3)_3{\equiv}N{=}O$	Borrowing union (no valence increase).	$(CH_3)_3{\equiv}N{\propto}O$
Double bond	O=O	Double bond, four electrons in common.	O=O
Triple bond	HC≡CH	Triple bond, six electrons in common.	HC≡CH

It may be noted that among the direct (that is, nonionizable) unions the single bond represents two electrons held in common; the double, four electrons; and the triple, six electrons. No place is given in the scheme to bonds consisting of one, three, or five electrons. This is entirely in accord with Langmuir's[3] postulate 11, and certainly in accord with the commonest types of

[1] Received for publication August 8, 1921.

[2] Philip. Journ. Sci. 19 (1921) 1.

[3] Langmuir, I., Journ. Am. Chem. Soc. 41 (1919) 888.

compounds. A discussion of some compounds which may be exceptions to this rule is the subject of the present paper.[4]

ODD MOLECULES

Lewis has called molecules which contain an odd number of electrons odd molecules, pointing out that they constitute an exceptional class. He has further observed [5] that such a molecule "will contain at least one atom with an uneven number of electrons in the shell. This may be called an *odd* atom." Literally construed, this means that only an even number of electrons can be shared, and ClO_2, for example, is $O{\infty}Cl{\infty}O$, with a vacancy in the shell of the chlorine atom. There is nothing in Lewis's fundamental postulates, however, against the supposition that an odd number of electrons can be shared, and the writer is inclined to think that, in certain rather exceptional cases, the facts warrant this view rather than Langmuir's postulate 11.

Admitting that there is a strong *tendency* for electrons to be shared in even numbers, we also know that there is a strong tendency for octets to be completed. Why, then, should odd molecules exist? In an odd molecule which of these tendencies is the stronger? Is the sharing of odd numbers of electrons confined to odd molecules? Let us consider a particular case.

CHLORINE DIOXIDE

In this molecule nineteen shell electrons are to be accounted for. The following possibilities present themselves:

1. The total number of shell electrons becomes even by transfer of one or more electrons to or from the kernels.
2. One of the shells in the molecule does not become completed to an octet, but to some odd number of electrons.
3. Two of the shells share, not an even number, but an odd number of electrons.

Explanation 1 is contrary to the strong evidence of the definiteness and stability of the kernel pair in He, Li, Be, Bo,

[4] The three-electron bond is not here presented as in any sense a new idea. It is entirely consistent with Lewis's postulates, but not with the more specific and remarkably successful postulates of Langmuir. Various suggestions are found in recent literature of three-electron bonds in ClO_2, C_6H_6, etc., cf. J. J. Thompson, Phil. Mag. 41 (1921) 535.

[5] Lewis, G. N., Journ. Am. Chem. Soc. 38 (1916) 771.

and of the pair and surrounding octet in F and the heavier atoms.[6]

Explanation 2 is less objectionable than 1 because atoms can exist under certain conditions with incomplete shells. When we consider, however, the high temperatures necessary to prevent such atoms as O and Cl from completing their octets by combination, and the marked reactivity which these atoms show in the nascent condition, it seems that ClO_2, though reactive in some ways, is not in the same class. Nor are there indications that ClO_2 contains an extra electron. Therefore explanation 2, while valid in ordinary dissociation at very high temperatures, does not apply to this case.

Explanation 3, namely, that five electrons are shared in ClO_2 seems to be the most reasonable. This is not inconsistent with the remarkably successful theory of pair sharing if we assume that there is a strong tendency to share in pairs, but that under certain conditions one or three electrons may be shared. To explain ClO_2 on the basis of this assumption it is necessary to show why this substance, containing the inherently unstable three-electron bond, is formed in reactions which would be expected according to the shared-pair theory to give Cl_2O_3 or Cl_2O_4.

The question of the structure of ClO_2 thus resolves itself largely into the reasons for the instability of Cl_2O_4 and Cl_2O_3 which brings us to one of the serious limitations of the octet theory. That is, the octet theory accounts for not only many compounds which exist, but also an enormous number which apparently do not and cannot exist. Langmuir has recently

[6] The only convincing explanation of the properties of N_2, CO, CN, and NO which has come to the writer's attention has been Langmuir's assumption (loc. cit 903) that in these molecules a double kernel is formed surrounded by a single octet. The odd electron in NO is in all probability very close to the center of the line joining the two nuclei, which is practically the central point of the octet. If each kernel even in NO definitely contains two electrons, as Langmuir's theory would indicate, the odd electron is one of three binding electrons situated between the kernels. It is also conceivable, as is pointed out on page 739, that under these conditions a group of four is (by magnetic or unknown forces) stable around each nucleus, only one electron being shared by the two groups. In any case the conditions are entirely different from those in a single kernel surrounded by an octet. The determining forces in ClO_2 must be very similar to those in neon and argon, whose kernels can take up or lose an electron only under the influence of a powerful impact, and then only momentarily.

attacked this difficulty from the physicist's viewpoint of minimum potential energy.[7] The fuller publication of calculations on the stability of various molecules will be interesting and valuable, but in the present state of physical knowledge can hardly be expected to cover completely the point now under discussion. From the chemist's standpoint a few general tendencies may be found which may serve to explain why Cl_2O, ClO_2, and Cl_2O_7 are relatively stable as compared to Cl_2O_3, Cl_2O_4, and Cl_2O_5.

THE TENDENCY TO SHARE ELECTRONS

"Chlorine, like fluorine, tends to form negative ions, but it differs from fluorine in that it can share electrons with oxygen, especially if the molecule takes up electrons from some more strongly electro-positive element. It shows a tendency like phosphorus and sulfur to share all 4 pairs of its electrons, if it has to share any."[8]

It seems to the writer more consistent with the facts to consider the tendency to share electrons as a *mutual tendency* which two atoms may have, rather than a single property of one of them. It seems that electrons can be shared only when an approximate equality exists between what may be called the electron binding strengths of the two atoms. The exact interpretation of this in terms of mathematical physics depends on one's ideas of the structure of the atom; but regardless of such disputed hypotheses, it may be considered as an empirical generalization standing on its own merits. A rough physical interpretation is that a very unsymmetrical union such as Ne∝O (: **Ne** : **O** :) is extremely unstable because, if it should momentarily take place, the shared pair would be held too close to the neon kernel for a strong attraction to exist between the shared pair and the weaker oxygen kernel. Therefore a very slight disturbance would separate the atoms in the form Ne + >O (: **Ne** : + **O** :) and thus lead to the formation of stable oxygen molecules, O=O (**O** **O**). In this symmetrical molecule neither kernel pulls the shared electrons beyond the control of the other kernel.

[7] Chemical and Met. Eng. 24 (1921) 554.
[8] Langmuir, I., Journ. Am. Chem. Soc. 41 (1919) 923.

Similarly the fluorine ion, F^- (: $\ddot{\mathbf{F}}$:), does not form a stable compound with an oxygen atom, $F^- \propto O$ (: $\ddot{\mathbf{F}}$: $\ddot{\mathbf{O}}$:) because the shared pair in such a compound would be drawn too far away from the oxygen kernel. The chlorine kernel, however, has an electron binding strength comparable to that of the oxygen kernel, and the ion, $Cl^- \propto O$ (: $\ddot{\mathbf{Cl}}$: $\ddot{\mathbf{O}}$:), is consequently fairly stable.

Although fluorine does not unite with oxygen it cannot be said to lack a tendency to share pairs, for F—F (: $\ddot{\mathbf{F}}$: $\ddot{\mathbf{F}}$:) is very stable. The second fluorine atom here can unite where the oxygen could not, because its electron binding strength matches that of the first fluorine atom. The present problem is not so much concerned with the differences between the electron binding strengths of the different atoms as it is with the variation of the electron binding strength of a single atom in different compounds. Such a variation is only one of the many observed consequences of the "electron shift."

An obvious way to increase the electron binding strength of an atom is to remove one of the electrons from its shell. The remaining electrons will then be held more tightly than before. Both chemical and physical evidence is quite definite on this point. This is important in connection with the metals, which are not, however, under discussion in the present paper.

In the case of a non-metallic, or chemically negative, atom there is such a tendency toward definite shell (generally octet) formation that the important variation in electron binding strength is not the one just described, but one produced by the

[a] Whatever the forces tending toward a stable configuration of electrons in the shell of an atom, the configuration is altered by the proximity of a foreign charge, and a displacement of one electron tends to shift all the electrons in the shell. Any hypothesis of atomic structure which does not admit of this view, or one very similar to it, is unsatisfactory from the standpoint of chemical evidence.

partial removal of two or more electrons from a shell. If two or more electrons are pulled away from certain other electrons in the same shell, these other electrons are less repelled by them and are consequently bound closer to the nucleus than before.

For example, the electrons in the shell of Cl^- (: **Cl** :) are assumed to be held by a balance of forces near certain equilibrium positions (which perhaps are the corners of a cube). The difficulty[10] which another atom would have in removing simultaneously two of these electrons, may be considered as a measure of the electron binding strength of unicovalent chlorine. Similarly the difficulty of removing two of the unshared chlorine electrons in $Cl^- \propto O$ (: **Cl** : **O** :) is a measure of the electron binding strength of dicovalent chlorine. By elementary physical considerations, and much more convincingly by chemical evidence, we are led to believe that the shared pair in $Cl^- \propto O$ (: **Cl** : **O** :) is farther from the chlorine kernel than the electrons in the shell of Cl^- (: **Cl** :), and that consequently the remaining (unshared) pairs in $Cl^- \propto O$ are held more firmly to the chlorine kernel than are the shell electrons in Cl^-. In general the effect of sharing a pair of electrons which were originally unshared is to draw this pair away from the kernel, and consequently allow all the other electrons to approach more closely to the kernel. That is, excluding double or triple bonds, *the electron binding strength of an atom increases as its covalence is increased.* With multiple bonds the reasoning is the same, but it is evident that the change from a single to a double bond moves a pair of electrons closer to, rather than farther from, the original bond, consequently weakening it.

[10] A physicist would probably prefer to speak of the potential energy of these electrons. This, or some other definition of "difficulty" would be feasible if we knew the mechanism by which another atom removes, or partially removes, the two electrons. At present it seems more satisfactory for a chemist to leave the physical definition somewhat open, and to judge of the "difficulty" directly from chemical data.

Returning now to fluorine, it is easy to see that if its electron binding strength in the unicovalent condition is too great for combination with any but a few atoms, still fewer compounds of dicovalent fluorine are to be expected. There is no reason, however, why certain atoms of very high electron binding strength cannot combine with dicovalent fluorine. The hydrogen atom is to be considered in this class, although occupying a unique position in it. In hydrofluoric acid we have some molecules containing dicovalent fluorine, and also, as has been pointed out by Latimer and Rodebush [11] some atoms of hydrogen in an unstable dicovalent condition.

Aside from hydrogen, the "inert" atoms seem to be the only ones capable of matching the electron binding strength of dicovalent fluorine. This suggests the possibility of an ion, $F^{'}-F^{+}-Ne^{+}$.

The oxygen atom, in the unicovalent condition has a binding strength which is very weak compared to that of fluorine. In the bicovalent condition its strength of course depends somewhat on the nature of the combined atoms, but it is comparable with that of unicovalent fluorine. Tricovalent nitrogen and quadricovalent carbon also have binding strengths of this same order of magnitude, so unicovalent fluorine combines with quadricovalent carbon in CF_4, and with tricovalent nitrogen in ONF.

THE CHLORINE OXIDES

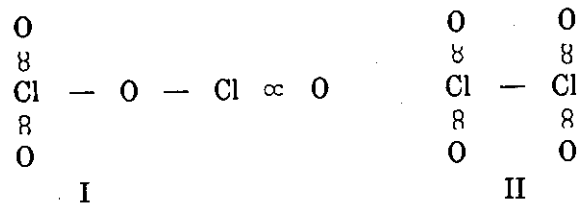
We are now in a position to return to the chlorine oxides. Unicovalent chlorine, due to the size of its kernel, has a binding strength which is much less than that of unicovalent fluorine or bicovalent oxygen, although somewhat greater than that of unicovalent oxygen.

According to this view Cl—F and Cl—O—Cl would be very unstable molecules. ClF is not known, but Cl_2O is. Although the formula Cl—O—Cl is often ascribed to this substance, the theory here presented indicates that Cl—Cl:O is the correct formula, because the evidence of chlorine compounds in general indicates that unicovalent chlorine is too weak to share a pair with bicovalent oxygen.

We might expect that bi- or tricovalent chlorine could share electrons stably with bicovalent oxygen, but apparently this is

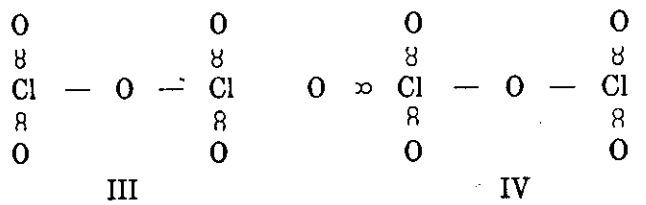
[11] Latimer, W. M., and Rodebush, W. H., Journ. Am. Chem. Soc. 42 (1920) 1425.

not the case, due to the considerable difference in size between the oxygen and chlorine kernels. Consequently Cl_2O_4 (I) and Cl_2O_5 (III) are not known. Some reactions which we might expect to yield Cl_2O_5 give instead ClO_2 and a perchlorate, while others give O_2 and Cl_2 by an exothermic rearrangement.



I

II

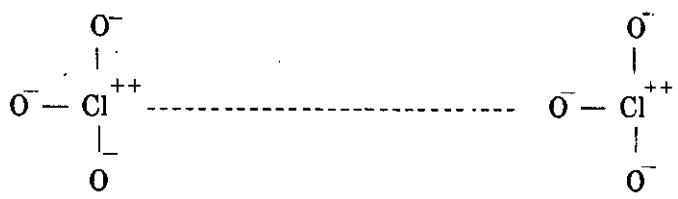


III IV

It seems that only quadricovalent chlorine (as in Cl_2O_7, formula IV) has sufficient binding strength to unite with dicovalent oxygen. This is the writer's interpretation of the fact that chlorine shows a tendency "to share all 4 pairs of its electrons if it has to share any." Chlorine heptoxide is therefore a relatively stable compound, but it is strongly endothermic as compared to Cl_2 and O_2, because the chlorine shell electrons are all displaced from their normal positions. This quasi-stability of chlorine heptoxide illustrates the fact that chemical problems deal much more with metastable than with stable equilibrium. Especially in organic chemistry it is well known that the relative potential energy of two sets of possible reaction products has often very little bearing on the question of which will be formed. This applies in a somewhat more limited way also to inorganic chemistry, as will be illustrated in the further discussion of the chlorine oxides.

Cl_2O_4 (formula I) probably exists to some extent in liquid chlorine dioxide. It would seem that formula II represents a much stabler compound, which may be present in certain mixtures of chlorine oxides of disputed composition, but would not be formed readily by the association of ClO_2 or by the decomposition of chlorates. The reason for this is the distinct polarity of ClO_2 and ClO_3^-, caused principally by the fact that the oxygen kernel has a positive charge of six, and the chlorine kernel seven. The unions in ClO_3^- are, therefore, what the writer has called

borrowing unions. Usually it is convenient to express such a union with a separate sign ∝, as already noted, to avoid confusion and show more graphically the valence relations. The equivalent sign $^{+}—^{-}$, however, is used in formula V. This formula shows two chlorate ions in the only position in which they would react smoothly with each other. The case of ClO_2 is practically identical.



V

If the above explanation is correct, Cl_2O_5 and Cl_2O_4 are unstable due to the inability of bi- or tricovalent chlorine to unite with bicovalent oxygen. ClO_2, which contains no bicovalent oxygen, is therefore formed in reactions from which we might expect Cl_2O_4 or Cl_2O_5. We may suppose that ClO_2 contains a three-electron bond without denying the strong general *tendency* toward sharing in *pairs*. In this particular case it seems that the pair-sharing tendency does not have an opportunity to manifest itself. The reasons against any disposition of the odd electron other than in one of the bonds have already been given.

Therefore, it seems highly probable that when an electron is removed from one of the oxygen atoms in the ion

: O : Cl : O : (O∞Cl∝O^{-}), forming the neutral molecule, : O : Cl : O . (O∞Cl—O—),

the vacancy caused in the oxygen shell is immediately filled by a closer approach to the chlorine shell in such a manner that one more electron is shared by the two atoms:

: O : Cl ⋮ O : (O∞Cl^{-}O).

Lewis's notation is here used, the writer's, which will be further explained in the succeeding section, being given in parenthesis. It is to be noted that the union last mentioned causes

no alteration in the number of electrons in the chlorine shell, which is the reason for not extending the new line across to the chlorine symbol.

The formula : $\overset{\cdot\cdot}{\underset{\cdot\cdot}{O}} : \overset{\cdot}{\underset{\cdot\cdot}{Cl}} : \overset{\cdot}{\underset{\cdot\cdot}{O}}$: is in accord with the physical and chemical properties of chlorine dioxide. This substance has a melting point of —76° C., boils at 10° C., and has in the liquid condition a molecular volume of 45. Sulphur dioxide, $: \overset{\cdot\cdot}{\underset{\cdot\cdot}{O}} : S \vdots \overset{\cdot\cdot}{\underset{\cdot\cdot}{O}} :$ which is almost isosteric with $: \overset{\cdot\cdot}{\underset{\cdot\cdot}{O}} : \overset{\cdot}{\underset{\cdot\cdot}{Cl}} \vdots \overset{\cdot\cdot}{\underset{\cdot\cdot}{O}} :$, melts at —76° C., boils at —10° C., and has a molecular volume of 45. Chemically, ClO_2 is characterized by a certain metastability similar to that of a perfectly dry mixture of hydrogen and chlorine.

THE HALF BOND

The three-electron bond might be accorded a special symbol, but it is more convenient to consider it composed of a two-electron and a one-electron bond. Since the bond composed of two electrons has long been called the single bond, and that of four, the double bond, it is convenient to call the one-electron bond a half bond. The three-electron bond may be considered as a single bond plus a half bond.

As is shown in Table 1, the customary line for an unsatisfied bond or affinity unit may be used to represent "vacancy in the shell for one electron." Two such lines from different atoms coalesce to form a normal union sign,—, again merely a straight line, joining two atomic symbols. Two affinity unit lines from the same atom may coalesce into the borrowing union sign, ∞. Each of these union signs represents a pair of electrons uniting two atoms, and shows by the ends of the line where the two vacancies are filled. In the case of the half bond only one vacancy is filled, one electron only being shared. It is convenient to represent this by a line considerably shorter than the normal union line, and placed adjacent to the atom in whose shell a vacancy is filled.

Although it is more convenient to consider the three-electron bond as made up of a single and a half bond, the half bond by itself is relatively unimportant. The half bond may explain cer-

tain peculiarities such as the combination of sulphuric acid and water now generally considered as secondary valence reactions. The three-electron bond, on the other hand, is undoubtedly found in benzene and all the thousands of benzenoid derivatives.

A consideration of organic compounds being deferred to a later paper,[12] two inorganic odd molecules will now be discussed briefly.

NITROGEN DIOXIDE

This compound (VI) is analogous to chlorine dioxide.

(VI) $O=N-O$ (VII) $\begin{matrix} & & O & \\ & & \| & \\ & O & N & O \\ & \| & & \| \\ O & N & - & N \\ & \| & & \| \\ & O & & O \end{matrix}$

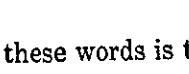
It is to be expected that the quadricovalent nitrogen in the associated form (VII) of this compound has a greater electron binding strength than tricovalent chlorine in the analogous compound Cl_2O_4. This is due not only to the smaller size of the nitrogen kernel, but also to the fact that a double bond with oxygen causes more displacement of electrons than two single bonds with unicovalent oxygen atoms. Therefore NO_2 associates to some extent in the gaseous condition, and entirely when in the liquid condition.

NITRIC OXIDE

When ten or more electrons gather around a single nucleus they always form a kernel pair surrounded closely by an octet. The kernel pair not surrounded by an octet is stable when attached to a nucleus of small charge, such as He, Li, Be, and Bo. Langmuir[13] has explained the properties of the nitrogen molecule and some similar compounds by assuming that the two nuclei retain their stable kernel pairs and share between them an extra pair, leaving eight electrons to form an octet around this double kernel. It is hardly more than a restatement of this explanation to say that when a kernel pair is attached to a nucleus carrying a positive charge of six or more, and is not stabilized by a closely surrounding octet, it is no longer the most stable group which can surround the nucleus, but is superseded by a group of four. In the nitrogen molecule, then, the nuclei are

[12] Cole, H. I., Philip. Journ. Sci. 19 (1921) 681, has already discussed in detail the triphenyl aryls, which form odd molecules under certain conditions.

[13] Cf. page 731, footnote 6.

surrounded by groups of four, in which two electrons are shared between the two groups. The reason for expressing the case in these words is that in nitric oxide,  , the seven kernel electrons can be accounted for as two groups of four in which one electron is shared.

SUMMARY

1. Reasons are given for considering that chlorine dioxide contains a three-electron bond.

2. The electron binding strength of atoms and its variation with the covalence is discussed in connection with the tendency to share electrons.

3. In conformity with older usage the single-electron bond is called the half bond and its importance is indicated.

CERCOSPORA LEAF SPOT OF COFFEE

By COLIN G. WELLES

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ONE PLATE

INTRODUCTION

The leaf spot of coffee caused by *Cercospora coffeicola* Berkeley and Cooke has not previously been reported from the Philippine Islands. It has not been observed in coffee plantations on the experimental farm of the College of Agriculture, Los Baños, Laguna, but it has caused rather severe spotting and ultimate defoliation of the nursery stock.

The occurrence of the disease at present may be negligible in the Philippine Islands but, unless precautions are taken, it may spread and cause considerable trouble and no little financial loss to the coffee industry.

This paper is a brief description of the disease and causal organism found here, and includes a short summary of related work in other countries.

REVIEW OF LITERATURE

The leaf spot under discussion is commonly known as "brown eye spot,"(1) "brown eyed disease," or berry spot."(2) These names are derived from the type and appearance of the disease in various localities.

The disease has been reported from many of the important coffee-growing regions of the world, including Mexico, Cuba, Trinidad,(3) Porto Rico,(2) Java, Uganda, and India.(1) In India the fungus has been found to parasitize the leaves only, but in Porto Rico(2) and other places(3) the berry spot is very serious, usually destroying all fruits attacked.

It is agreed by all who have worked with the causal organism, that the disease is due to *Cercospora coffeicola* Berkeley and Cooke. As the organism found in the Philippines compares accurately with the organisms previously described, no details will be reviewed here.

The symptoms described by Butler(1) on the leaves, as well as those described by Cooke, are identical with those of the local trouble.

Faucett(2, p. 22) finds that:

> On the berries the largest spots, those fastening the fleshy part of the fruit to the parchment, almost always are found on the upper side. Any part of the fruit may be attacked, the spots appearing at first as small brown discolorations. They are especially common on the nearly ripe berries. At the time of picking, the larger spots cover about half of the fruit and are velvety with the spore-bearing outgrowths of the fungus.

He also states that the fruits become infected from the spores formed on leaf lesions.

Butler(1) and Faucett(2) are agreed that the leaf spot may be readily controlled by judicious spraying with Bordeaux mixture. According to Faucett, the fruit lesions may be reduced by controlling the leaf spot.

THE DISEASE IN THE PHILIPPINES

The attack of *Cercospora coffeicola* Berkeley and Cooke in the Philippine Islands is confined to leaves, so far as present observations indicate. The disease has been observed only on nursery stock and has not been found on mature trees. A thorough survey of the coffee plantations of the Islands has not been possible; so the limits and seriousness of the disease are not known at the present time.

SPECIES ATTACKED

Several species of coffee seedlings are grown in the college nursery, and no effort is made to keep them isolated. Because of this any spores from disease lesions may readily be transferred to seedlings of all species.

Under such conditions the leaf spot would be expected to parasitize all susceptible species. However, of the five species grown, *Coffea bukobensis* is the only one affected by the disease.

The following species are unattacked: *Coffea liberica, Coffea robusta, Coffea congensis,* and *Coffea conophora.*

The locality from which the disease came is a matter of speculation for, although the plantations as well as the nursery have been frequently visited by collectors and pathologists for the past five years, no mention has been made of this leaf spot.

No coffee seedlings or seeds have been brought to the college plantation since 1916, when *Coffea liberica* was obtained from Lipa, in Batangas, a neighboring province. It is well to note

that this species is not parasitized by *Cercospora coffeicola* Berkeley and Cooke in the college nursery.

Coffea bukobensis, the only diseased species, was obtained from the Kaiserliches Biologisch Landwirtschaftliches Institut, Hafen Taya, in 1914. It is, however, hard to believe that the fungus has been here for so long a period unnoticed.

SYMPTOMS

Up to the present time the fungus has been found to attack only seedlings in the nursery; hence the berry spot, so destructive in Porto Rico,(1) is not known.

The lesions when young are light brown. Later the center portion turns grayish, exhibiting concentric striations and encircled by brown rings. The lesions are found mostly on the upper surface of the leaves. At first they do not penetrate through the leaf, but later a distinct spot is produced on the under surface.

In some instances the spots coalesce and form an irregular lesion. In severe attacks the leaves turn brown and fall off, frequently leaving but a tuft of young leaves on a long stem.

CAUSAL ORGANISM

The organism which causes this leaf spot is *Cercospora coffeicola* Berkeley and Cooke.

The typical *Cercospora* conidiophores and conidia are produced in the grayish central portion of the lesions.

The conidiophores occur in bunches which are formed in stomatal openings. They measure from 60 to 150 μ long and 4 to 6 μ wide and are 5- to 10-septate.

The conidia are from 70 to 130 μ long and 5 to 7 μ wide with from 5 to 12 septa.

Butler(1) reports the formation of secondary conidia on the germination of the primary conidia, but these have not been observed here. The conidia germinate by means of long, slender, germ tubes. Several may arise from one conidium.

CONTROL

Spraying experiments carried on with Bordeaux mixture prove conclusively that the brown eye spot may be easily controlled.

Spraying every two weeks is recommended. If the attack is limited in extent there is no reason why complete eradication may not be effected.

In Porto Rico(1) it was found that shading reduced the berry loss from 10 to 30 per cent. At the present writing this has not become necessary here, however.

SUMMARY

1. Leaf spot of coffee, caused by *Cercospora coffeicola* Berkeley and Cooke has been found on nursery stock of the College of Agriculture, Los Baños, Laguna.

2. This is known as "brown eye spot," "brown eyed disease" or "berry spot," described by Butler, by Faucett, and by Cooke.

3. In the Philippines attack is confined to leaves and therefore it is not very serious. It may spread to berries and become more dangerous.

4. It is found only on *Coffea bukobensis*. The source of the disease is unknown.

5. The causal organism checks with the previously described *Cercospora coffeicola* Berkeley and Cooke.

6. The disease was controlled by spraying every two weeks with Bordeaux mixture.

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2. FAUCETT, G. L. Fungus disease of coffee in Porto Rico. Porto Rico Agr. Exp. Sta. Bull. 17 (1915) 21–24.
3. COOKE, MELVILLE THURSTON. The diseases of tropical plants. Macmillan & Co., London (1931) 163–166.

ILLUSTRATION

PLATE 1. CERCOSPORA COFFEICOLA BERKELEY AND COOKE

FIG. 1. Germinating conidia, showing various methods of germ tube production. Drawn with the aid of the camera lucida. × about 500.

2. Conidiophore. Drawn with the aid of the camera lucida. × about 500.

3. Conidia. Drawn with the aid of the camera lucida. × about 500.

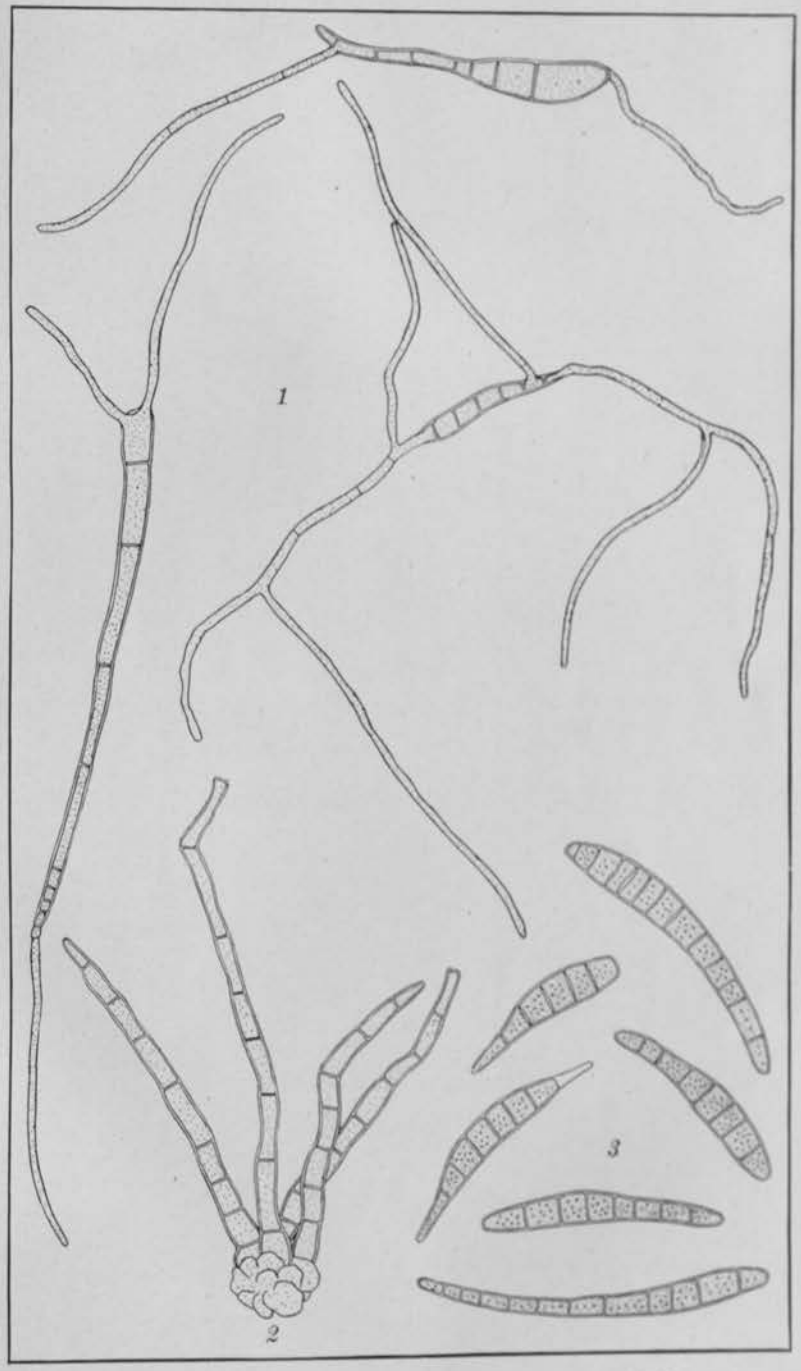

PLATE 1. CERCOSPORA COFFEICOLA BERKELEY AND COOKE.

CERCOSPORA LEAF SPOT OF AVERRHOA CARAMBOLA[1]

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TWO PLATES

A very serious leaf spot, causing partial or complete defoliation of *Averrhoa carambola* Linnaeus has been observed in the experimental orchard of the College of Agriculture, Los Baños, Philippine Islands. The writer is unable to find any note that describes a *Cercospora* leaf spot on the above-named host.

Averrhoa carambola is a native of tropical America, but now occurs in all tropical countries. It is cultivated for its acid fruits. The trees under observation were brought to Los Baños about eight years ago from China and have shown fairly normal development since that time. No leaf spotting has been recorded on this host by any of the local plant pathologists or collectors.

The spotting was first noticed about June 25, 1921, approximately at the beginning of the wet season. At this time, however, spotted leaves were few in number and the attack was scarcely noticeable.

On July 15, a different condition existed. The trees showed partial defoliation, and a careful count showed that 100 per cent of the larger leaves were infected with from one to ten lesions. At this time it appeared that a thorough spraying would have to be resorted to if the trees were to be kept from complete defoliation.

This paper presents studies made upon the disease with special stress on the causal organism and control measures.

SYMPTOMS

The disease appears as a spotting of the leaves of *Averrhoa carambola*. When young the lesions appear as irregular, yellow, chlorotic spots, from 3 to 5 millimeters in the largest dimension. These chlorotic areas may coalesce and form a large irregular

[1] The author wishes to express his appreciation for the constructive criticism of Mr. H. Atherton Lee, of the Bureau of Science.

blotch, giving the leaf a mottled appearance. This type of lesion is found on both old and young leaves.

Later the tissue in the central portion of the lesion dies and turns grayish brown or dirt colored. This central area is always surrounded with a band of yellow, chlorotic tissue, from 1 to 2 millimeters wide.

The growth of the lesion seems to be definitely limited, for when the development has progressed to a certain point the tissue, both dead and chlorotic, falls out and leaves a shot-hole condition. After this shot-holing has taken place the leaf, if it is not too severely parasitized, lives and carries on to a greater or less extent its photosynthetic function.

A yellowing of the tissue develops with the more severely spotted leaves. This, in turn, is followed by defoliation which seems to be very serious in the present attack.

Black lesions form on many fruits, causing no noticeable damage, however. Many such lesions have been examined, but their connection with the *Cercospora* leaf spot has not been established. This connection, nevertheless, seems probable.

HOSTS ATTACKED

A related species, *Averrhoa bilimbi* Linnaeus, also pantropic, is grown in great abundance locally. Many trees have been observed, but no leaf spot caused by *Cercospora* has been found. The attack of the fungus seems to be confined to *Averrhoa carambola*.

ECONOMIC IMPORTANCE

The trees grown at the College of Agriculture number about forty. The fungus under discussion is found on each tree and causes no small loss. The leaves, which are more than half mature, show 100 per cent infection, with several lesions on each leaf. The trees which have been left uncontrolled have been nearly defoliated. If defoliation is repeated the loss of the trees is imminent (Plate 1).

CAUSAL ORGANISM

The organism that causes the leaf spot of *Averrhoa carambola*, discussed in this paper, belongs to the genus *Cercospora*.

The fruiting bodies, consisting of conidiophores and conidia, are born in the grayish brown central portion of old lesions. They occur on both sides of the leaf, but more abundantly on the lower surface.

The conidiophores are produced in clumps which arise in stomatal openings. They are light brown, simple, erect, and are 3- to 7-septate. The average conidiophore measures 52.51 μ long and 5.04 μ wide, the extremes being 61.64 to 47.84 μ long and 5.52 to 4.41 μ wide.

The conidia are hyaline, short, straight or slightly curved, erect, larger at the basal end, and taper slightly to a blunt point. The average conidium measures 45.26 μ long and 4.23 μ wide, the extremes being 67.52 to 27.96 μ long and 5.2 to 2.8 μ wide. They are 4- to 7-septate.

CULTURAL CHARACTERISTICS

Isolation is easily accomplished by plating the diseased tissue directly on corn meal medium. The mycelium develops with moderate rapidity.

At first the mycelium appears in a very thin growth. Later it develops into a rather thick mass of closely packed hyphae. With age the central portion of the mycelial growth turns grayish green and is surrounded with a thin band of white mycelium. The cultures have been kept for but a short period, so no fruiting bodies have developed.

CERCOSPORA AVERRHOI sp. nov.

Conidiophores light brown, simple, erect, 52.51 by 5.04 μ, the extremes being 61.64 to 47.84 by 5.52 to 4.41 μ; tufted, arising from stomatal openings, on both surfaces of the leaf but more commonly on the lower surface. Conidia hyaline, short, straight or slightly covered, erect, 4- to 7-septate, average measures 45.26 by 4.23 μ, the extremes being 67.52 to 27.96 by 5.2 to 2.8 μ. Readily cultured on starchy media, producing first thin, white hyphae, with age becoming thickly matted and grayish green; spores not commonly produced in culture.

On leaves of *Averrhoa carambola* Linn., causing amphigenous, circular or irregular, grayish brown spots with yellow borders, 3 to 5 millimeters in width; at Los Baños, Laguna Province, Philippine Islands.

CONTROL

Control experiments with Bordeaux mixture were commenced on July 13, 1921, about the beginning of the rainy season. The Bordeaux mixture was made up according to the following formula: 1.8 kilograms copper sulphate, 2 kilograms stone lime, 190 liters of water.

The ten diseased trees that were used were not especially selected for the purpose. A count of the older leaves showed that 100 per cent on all trees were infected.

Six of the trees were sprayed thoroughly with Bordeaux mixture and were examined after two weeks. The sprayed trees were not defoliated to a great extent and the number of leaves were in striking contrast with those on the unsprayed trees. Plate 1 shows the results very distinctly.

Counts were made of diseased leaves from sprayed and unsprayed trees at this time. The number of leaves exhibiting young lesions on the sprayed trees was 20 per cent of all observed. One hundred per cent of the leaves from unsprayed trees were parasitized, showing from one to four young lesions and frequently as many old ones. The number of new infections, then, was reduced 80 per cent due to the Bordeaux mixture application. Frequent heavy rains gave optimum conditions for infection.

By August 1 a different condition existed. The trees that had been sprayed were still holding their less seriously diseased leaves. The unsprayed trees had become entirely defoliated and had put forth new leaves, which by August 8 had not developed any lesions.

This experiment conclusively proves that Bordeaux mixture, if applied carefully, will give perfect control. If the spray is used once every two weeks until the disease disappears and if the fungus does not attack other hosts, eradication should be easily accomplished.

SUMMARY

1. A very serious *Cercospora* leaf spot was found in the experimental orchard of the College of Agriculture, Los Baños, Philippine Islands, on *Averrhoa carambola*.

2. It attacks leaves and perhaps fruits. The young leaf lesions are yellow, later turning grayish brown, and finally either falling out or causing the death of the leaf.

3. *Averrhoa bilimbi* is not attacked.

4. The leaf spot threatens the life of the trees in the orchard by repeated defoliation.

5. The name *Cercospora averrhoi* sp. nov. is suggested to designate the causal organism.

6. Control by spraying with Bordeaux mixture is very efficient. By repeated sprayings every two weeks the disease can be efficiently controlled. Complete eradication would seem to be possible.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Appearance of a tree, *Averrhoa carambola*, two weeks after one application of Bordeaux mixture. Young lesions reduced 80 per cent.

2. Appearance of a tree, *Averrhoa carambola*, that was not sprayed. Partial defoliation due to *Cercospora averrhoi* sp. nov. Both trees had the same percentage of infection when the spray was applied.

PLATE 2

FIG. 1. Diseased leaves showing position and appearance of lesions, × 1. Drawn by E. Roldan.

2. Group of conidiophores, × 600.

3. Conidia, × 600.

4. Mycelium from pure culture on potato-glucose-agar.

Figs. 2, 3, and 4 were drawn with the aid of the camera lucida by C. C. Nacion.

Fig. 1.

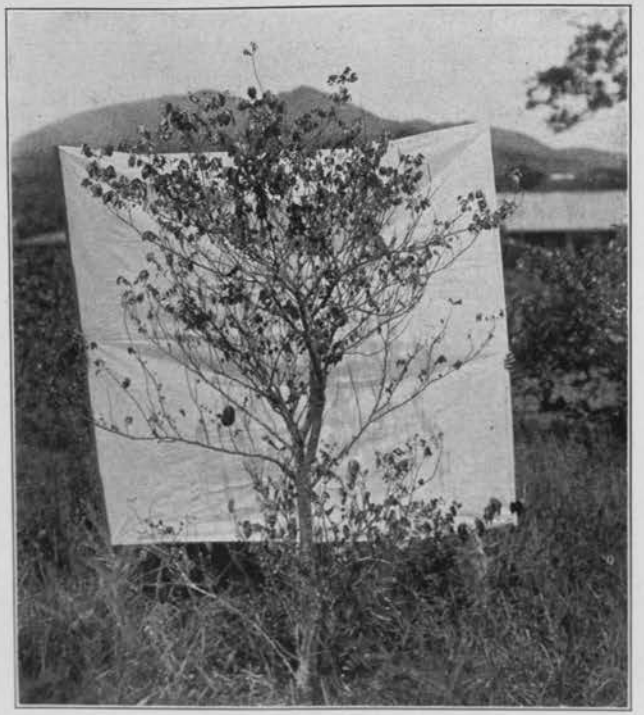


Fig. 2.

PLATE 1.

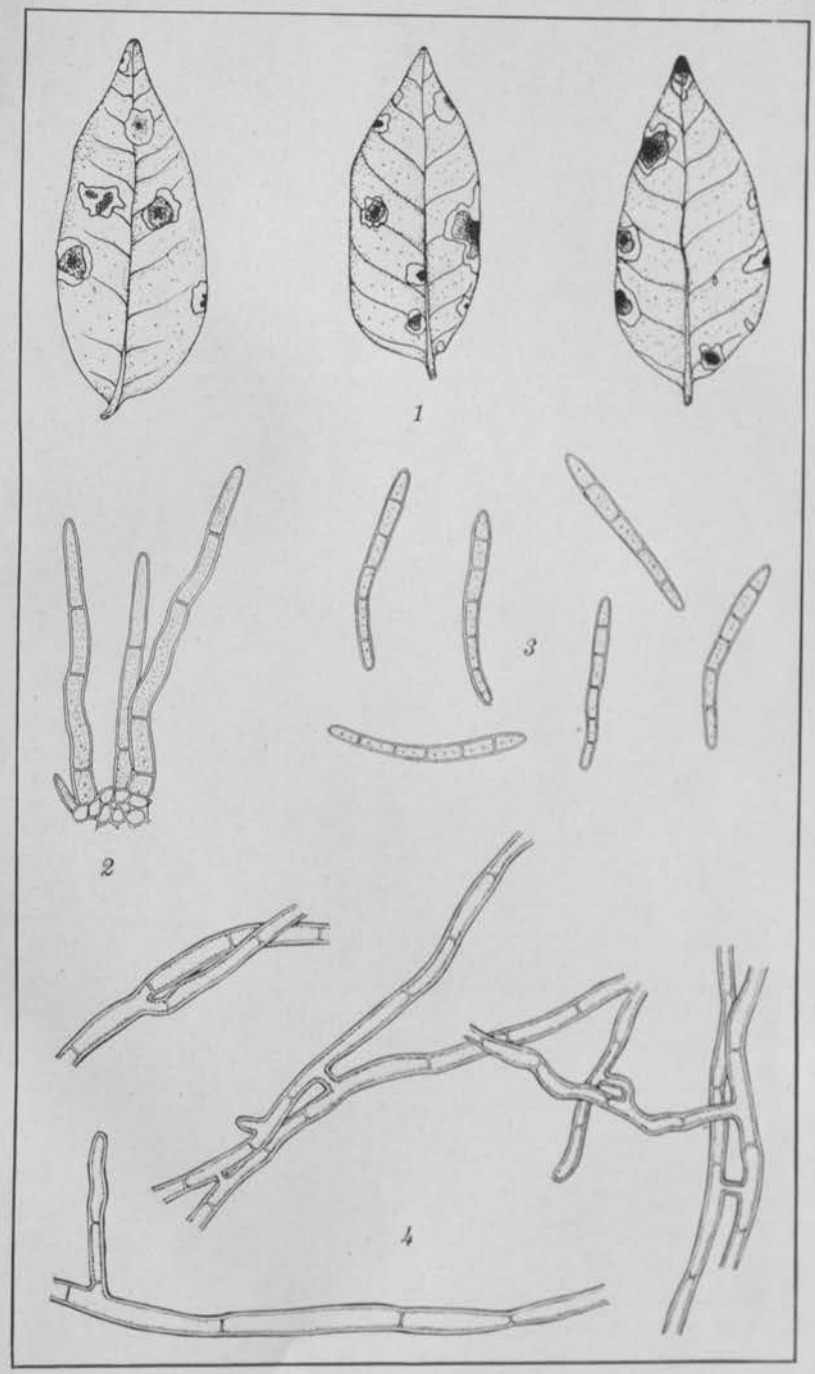


PLATE 2. CERCOSPORA LEAF SPOT.

REVIEW

An Introduction to | Bacterial Diseases | of Plants | by | Erwin F. Smith | in charge of Laboratory of Plant Pathology, | Bureau of Plant Industry, | United States Department of Agriculture, Washington, D. C. | [inscription and motto, 7 lines] | Philadelphia and London | W. B. Saunders Company | 1920 | Cloth, pp. i-xxx + 1-688, including index. Price, $13.25.

Dr. Erwin F. Smith has been associated with the study of the bacteria in relation to plant diseases since the earliest days of the subject; in fact his insistence is almost entirely responsible for the standards of experimentation in this subject which compare favorably with those from any other field of scientific endeavor. His knowledge of the development of the subject and his intimacy with the other earlier workers, for example, Burrill, Waite, and Arthur in America, and Wakker and Savastano in Europe, place him in a position to discuss the present and earlier status of this branch of science much more fluently and with more authority than any other person has been or will be able to do.

The book is of chief merit to plant pathologists in that it reflects the personality of Dr. Erwin Smith; it will live long after Doctor Smith, perpetuating his scientific attitude which, even more than his many notable additions to our knowledge of plant diseases, is his greatest contribution to our profession. Doctor Smith discusses in his last chapters such subjects as ethics, ideas, coöperation in research, and the ownership of a man's research—subjects upon which few men have the courage to define their attitude. He is the only man in our science from whom we would take such a discussion, and we will appreciate it more as the years go on.

Part I of the book is probably the first comparative discussion of the different bacterial diseases of plants and their causal organisms that we have had. Here also Doctor Smith's personal association with the researches on the diseases under discussion makes the work extremely valuable. If we should criticize we would ask Doctor Smith to present this discussion more in detail, from the wealth of knowledge he has on the

subject. Part II on methods of research also could be made into one or several volumes by Doctor Smith.

Part III, a discussion of fourteen selected bacterial diseases, although intended primarily for the undergraduate student, contributes much that is valuable to pathologists in unknown fields, as an aid in diagnosis and general knowledge. Doctor Smith is not subject to the criticism applicable to many authors in that he has not confined the horizon of plant diseases to the District of Columbia, or the United States, or even North America. There is frequent mention of plant diseases in the Tropics and the oriental countries as well as in Europe, South America, and South Africa.

Part IV contains extremely interesting chapters on the production of tumors in the absence of parasites and on experimental teratosis. Several of the reviewer's associates in the medical sciences have been interested in these chapters. They are of great interest to all biologists. Part V is really the most important of the book, containing some good honest fundamental advice on the presentation of results, ethics, and coöperation. Many investigators in the Philippine Bureau of Science in fields of research other than plant pathology have read the chapters on these subjects and have appreciated the great stimulus conveyed in these discussions.

Few typographical errors are to be found; among those noted is the misspelling of Philippines (p. 694) and *Phyllosticta* (p. 59).

The book is a contribution not only, as it was primarily intended, to the younger students of plant pathology, but to research men in all sciences. It is a valuable stimulus to a correct scientific attitude and many an investigator would do well in the rush of work to sit down for an hour and reread Part V of this book. With the publication of this book, we must, moreover, acknowledge appreciation to Doctor Smith for his achievement almost unaided in building up and placing on a firm foundation a comparatively new science.

H. A. L.

ERRATA

Volume 18, number 4, page 460, line 6, *for* plastogamy *read* plasmotomy.

Volume 19, number 1, page 7, line 29, *for* N ∞ N=O *read* N ∞ N=O.

Page 9, line 3, *for* way *read* may.

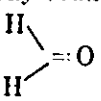
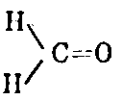
Page 17, line 1, *for*  *read* 

Plate 1, *for* Calotermes *read* Kalotermes.

Volume 19, number 3, page 380, line 18, *for* Archimenes sesamoides Vahl *read* Achimenes sesamoides Vahl.

Volume 19, number 5, page 584, line 14, and page 589, line 34, *for* maculipes *read* maculicrus.

Doctor Heller has requested the last change as he has recently noted that the name *Mecistocerus maculipes* is preoccupied, having been used for an African species described by Faust.

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[New generic and specific names and new combinations are printed in clarendon; synonyms and names of species incidentally mentioned in the text are printed in *italic*.]

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